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**Does a body mass index greater than 40 directly correlate with clinical outcomes in total
joint replacements?**

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N997 Independent Study

PERMISSION

Title

Department Nursing

Degree Master of Science

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Abstract

Obesity is a growing concern in the United States, and the effects of extra body mass puts multiple strains on all different body systems and body parts. Those who are obese are more likely to develop osteoarthritis at a quicker rate than those who are not obese; also placing them at an increased risk to need a joint replacement (Arthritis Foundation, 2020). Throughout the orthopedic literature there is consensus and vast evidence that increasing body mass index and obesity are correlated with poor clinical outcomes post total joint arthroplasty; though, there is no agreement on at what threshold of body mass index does the risks of surgery outweigh the benefits. The literature review was conducted using both CINAHL and PubMed databases. 348 articles were initially identified. English language, five years old or less, and peer reviewed were used as limitations. Key words included: “body mass index threshold of 40” AND “total joint replacement”, “BMI parameters” AND “knee replacement”, “body mass index threshold of 40 and total joint replacements”, and “body mass parameters and total joint replacements.” This reduced articles to 16. Upon further review, 10 were identified as relevant for this review. The case study and literature review will demonstrate the effect of obesity on clinical outcomes in total joint replacement patients, highlighting that a body mass of greater than 40 is correlated with poor clinical outcomes and can serve as the new threshold to guide patients and surgeons to make an informed and educated decision on management of osteoarthritis in morbidly obese patients in need of joint replacement.

Background

Obesity has become a public health crisis in the United States, around 35% of the adult population is obese (Martin et al., 2017). Obesity is classified as a body mass index (BMI) of greater than 30kg/m, there are several different classes of obesity including class 1 (30-34.9), class II (35-39), and class III or morbid obesity which is BMI greater than 40 (Martin et al., 2017). Obesity often affects our body parts and systems; those with obesity are more likely to suffer from multiple comorbidities as well. Obesity strains the joints both mechanically and physiologically which ultimately progresses to the development of osteoarthritis. Greater weight from obesity and high body mass index puts greater force and impact on articular cartilage, leading to articular cartilage inflammation and destruction or osteoarthritis. These physiological changes often result in a need for total joint replacements. With the greater impact of force and weight on the joints of those who are obese there is a higher incidence of osteoarthritis thus leading to an increase in total joint replacements in this population (Springer et al., 2013). Springer et al. (2013) found that when compared to non-obese patients those with a BMI greater than 40 are nearly ten times more prone to need a total hip replacement.

Martin et al. (2017) found a strong correlation with obesity and worse clinical outcomes in patients who had total knee replacements than those who are not obese. Furthermore, it was found that when BMI trends into the morbid and super-obese classification complication rates of total joint replacements rise including infection and an increase in rates of reoperation and revision. In 2013 a workgroup of the American Association of Hip and Knee Surgeons Evidence Based Committee (Springer et al., 2013) performed a literature review on obesity and total joint arthroplasty. One of the group's main focus was facilitating and supplementing the patient-surgeon discussion along with provoke further research on the topic. Research clearly identifies

increased risks associated with obesity and total joint replacements; however, it is difficult to specifically quantify given obese patients often have other comorbidities such as diabetes or heart disease (Springer et al., 2013).

Currently there is not one specific clinical guideline that endorses a specific BMI threshold for postponing total joint arthroplasty. According to Orthoguidelines (2015) there is evidence that supports obese patients have less improvement in outcomes post total knee arthroplasty and identify they have increased risk of periprosthetic joint infection. Additionally, patients with a BMI greater than 40 should be advised of their risk of less improvement in functional outcomes post TKA. Springer et al. (2013) reported findings that morbidly obese (BMI >40) and super obese (BMI>50) have surgical complications that offset the benefits of total joint arthroplasty including infection and increased revision rates. Additionally, it was indicated in those who are need of a total joint replacement who have a BMI greater than 40 there should be reconsideration to delay surgery. There was also a call for the further need of research on the impact of obesity on total joint arthroplasty. Since the Springer et al. (2013) article years seven ago there has been a lack of updated evidence along agreement on what exact body mass index should serve as a threshold for poor clinical outcomes in total joint replacement patients. Up to date evidence could help guide health care professionals to make decisions regarding morbidly obese patients and total joint arthroplasty.

The case report referenced in the appendix will introduce 46-year-old female who has a history of obesity (BMI 34), hypertension, diabetes type II, and hypothyroidism who presents for a preoperative evaluation. This patient fell six months ago and is in need of a surgical repair for her right meniscus. With the patient's current body mass index of 34, she is classified as obese. With her obesity history, she is at an increased risk of developing osteoarthritis and the need for

total joint replacement. The case study and literature review will demonstrate the effect of obesity on clinical outcomes in total joint replacement patients, along with highlight the clinical role of the nurse practitioner in the management of this case.

Literature Review

Literature Search

Databases during the initial literature search involved two databases of CINAHL and PubMed via the University of North Dakota's Medical School Library to investigate articles and resources on the topic of obesity and total joint replacements. Parameters for all searches included only English language and a date range of 2015-2020. The original search for literature in CINAHL involved key words of "obesity" AND "knee replacement" which total 249 articles; the next search involved "body mass index" AND "total joint replacements" which elicited 255 articles. To narrow results the next search used "body mass index threshold of 40" AND "total knee replacement" generated five articles, "body mass index threshold of 40" AND "total joint replacement" generated seven articles, and "BMI parameters" AND "knee replacement" produced 26 articles. PubMed generated very similar results when using terms of "body mass index threshold of 40 and knee replacement" generated seven articles, "body mass index threshold of 40 and total joint replacements" produced eight articles, and "body mass parameters and total joint replacements" gave 93 articles to review. There was also review of reference sections on the articles discovered from the most specific searches. A total of 16 articles were chosen for further examination based on the performed literature review. The reference lists of these articles were also examined for additional resources. 10 articles were finally selected for the literature review of this paper. The six articles were discarded due to not directly citing a body mass index of 40 having the direct effect on clinical outcomes in total joint replacements.

Topic Formulation

Obesity is an epidemic affecting the United States of America, as one-third of the United States population is considered overweight or obese (Alvi et al., 2015). The Arthritis Foundation (2020) cites the increased prevalence of osteoarthritis is directly correlated to the increase in obesity in our country. Springer et al. (2013) found that the likelihood of having knee osteoarthritis is four times in obese men and five times in obese women. There is a direct correlation with obesity and osteoarthritis in the literature. The rate of progression is often compounded by one's obesity placing these individuals at a higher need of joint replacement while also putting them at danger of complications and worse outcomes post-surgery (Arthritis Foundation, 2020). Morbid obesity has been correlated with early surgical complications post total joint arthroplasty including thromboembolic events and wound infections (Wagner et al., 2016).

Obese persons have increased rates of osteoarthritis often leading to total joint replacement consideration (Springer et al., 2013). Nearly half the patients who get a primary total knee replacement and around one third of those who get a total hip replacement are obese (Lubekke et al., 2016). A workgroup of the American Association of Hip and Knee Surgeons Evidence Based Committee looked to evaluate obesity and total joint arthroplasty. It was discovered that a BMI greater than 40 or morbidly obese appeared to be the threshold where perioperative complications such as infection and revision rates dramatically increased in total knee arthroplasty (TKA) The recommendation was also then suggested to be used in patients requiring total hip arthroplasty (THA). The committee calls for further research and evidence to assess the exact threshold of BMI in total joint replacements and the effect of obesity on total joint replacement outcomes (Springer et al., 2013). According to Lubbeke et al. (2016) the

current literature on obesity categories and the outcome of infection only compares above and below a BMI of 30. Shohat et al. (2018) cited inconsistency in the literature for a threshold on BMI and the risk for infection that can outweigh the benefits of surgery.

Synthesis of Current Literature

This case study involved a 46-year-old female patient who presented for preoperative evaluation for a meniscus repair. When examining the overall case study of this 46-year-old female who has a BMI of 34 and is considered obese, she is at risk for the future development of osteoarthritis and there is a well-known link between obesity and osteoarthritis requiring total joint replacement (Alvi et al., 2015). A body mass index of greater than 40 has been cited in the literature as a potential threshold for poor outcomes post total joint arthroplasty but further research was needed to solidify this threshold. In this synthesis of current literature, we are examining the association of BMI greater than 40 and the risk of poor clinical outcomes in total joint arthroplasty.

Alvi et al. (2015) is the novel study highlighted by OrthoGuidelines (2015) which emphasized the fact that those with a BMI greater than 40 had increased morbidity including greater rates of medical complications, surgical complications, and surgical site infections. In this study 13,250 patients from the American College of Surgeons-National Surgical Quality Improvement Program data base from the years of 2005-2011 were put together to evaluate the effect of BMI on perioperative outcomes in THA/TKA patients using a nationally representative cohort using matched multivariable statistical analysis to help control for confounders such as comorbidities, age, or smoking status. There is particular evidence of the greater infection rates in this population. Alvi et al. (2015) cited specifically that those with a BMI greater than 40 were associated with increased surgical site infections and a particularly increased risk of superficial

wound infection. Si et al. (2015) adds additional evidence when they reported a BMI greater than 40 serves as a threshold for the greatest risk of deep infection post total joint arthroplasty.

Lubbeke et al. (2016) compared the incidence of BMI and prosthetic joint infections and discovered the rate of infections for normal weight was 1.8 cases per 1,000 persons comparatively to the obese class III the rate was 6.7 cases per 1000 persons. Wagner et al. (2016) large consecutive series concluded that those with greater BMIs coincided a more advanced risk especially at the mark of a BMI of 40 or greater. When paralleled with a BMI of 18-24 the patients with a BMI greater than 40 had double the risk of superficial or deep wound infection, while also an amplified risk of deep periprosthetic infection (Wagner et al., 2016).

Shohat et al. (2018) set out to discover if there is a BMI cutoff threshold that is associated with increased risk for joint infection through a retrospective study of primary total hips and total knees between 2006-2015 with 18,173 patients. Shohat et al. (2018) verified BMI as an independent risk for prosthetic joint infection. Of particular note was at the 90-day post-surgery mark the only patients who were at higher risk of prosthetic joint infection was the obesity class III or BMI greater than 40. The BMI greater than 40 group had a threefold increased risk thus Shohat et al (2018) recommended that benefits and risks must be measured in this group prior to surgery. Kandil et al. (2015) adds even further evidence when they reported the morbidly obese group was also linked to considerably increased rates of infection when compared to obese or non-obese groups. Different categories of infection have been documented throughout the literature that are correlated with increasing BMI. Si et al. (2015) linked increasing BMI to increased rates of any infection, while the cut off of BMI > 40 served as the threshold for the greatest risk of developing a deep infection. Si et al. (2015) aimed to bring the threshold even further down when they called attention to their results that the BMI of 30 cut off serves as a

threshold in which patients begin to have increased risk of infection following TKA. Pugely et al. (2015) reported in their large review of the American College of Surgeons National Surgical Quality Improvement database during the years 2005-2010 in the total joint arthroplasty cohort the patient's BMI was the highest risk factor for 30-day surgical site infection, this risk was greater in those with a BMI > 40. There is a clear correlation in the literature reviewed that a BMI of greater than 40 has a significant effect and correlation on the risk of infection in total joint arthroplasty (Alvi et al., 2015; Kandil et al., 2015; Lubbeke et al., 2016; Meller et al., 2016; Pugely et al., 2015; Si et al., 2015; Shohat et al., 2018; Wagner et al., 2016).

Infection is not the only poor clinical outcome that is connected to the morbidly obese population undergoing total joint replacement. Throughout the literature surgical complications are correlated with a BMI greater than 40. Alvi et al. (2015) reported that a body mass of greater than 40 had greater rates of returning to the operating room (OR) and longer OR to discharge times. Lubbeke et al (2016) agreed with these findings when they cited that those with a BMI greater than 40 were more likely to have surgery greater than 180 minutes. Meller et al. (2016) cited that morbidly obese patients were more at risk for complications such as wound dehiscence. Additional surgical complications in the morbidly obese demographic include the increased risk of reoperation, component failure, and implant revision or removal. The risk of revision related to mechanical failure due to aseptic loosening and polyethylene wear was correlated with BMI, while the peak of this risk was at a BMI of 40 (Wagner et al., 2016). Christensen et al. (2018) determined that increasing BMI was linked to greater association of implant revision or removal, with a 19% increase in revision need for any reason per one standard deviation increase in BMI (Christensen et al., 2018). Most notable was the peak in rise of risk for revision due to mechanical failure and for aseptic loosening was at a BMI of 40.

Sayed-Noor et al. (2019) solidified the surgical risks and complications when they reported that the morbidly obese have double the risk of reoperation or revision. Pugeley et al. (2015) cited that not only was the morbidly obese patient more likely to have revision, they had an increased risk of surgical site infection after their revision as well. The surgical complications associated with a BMI greater than 40 in total joint arthroplasty are clearly documented and correlated in the literature (Alvi et al., 2015; Christensen et al., 2018; Lubbeke et al., 2016; Meller et al., 2016; Pugeley et al., 2015; Sayed-Noor et al., 2019; Wagner et al., 2016).

The literature consistently references that a BMI of greater than 40 is associated with clinically poor outcomes post total joint arthroplasty. There is particular evidence in the literature correlating significant medical complications on top of infection in those patients undergoing total joint arthroplasty who are morbidly obese. Shohat et al. (2015) concluded that this group has a threefold increase risk of complications. Alvi et al. (2015) cited that the obesity class III or a BMI greater than 40 was linked to increased morbidity when compared to those of normal weight or overweight. Kandil et al. (2015) aimed to look at obesity and morbid obesity and their related medical comorbidities with their association of increased complications post unicompartmental knee arthroplasty. Obese (BMI 30-39) and morbidly obese (BMI >40) patients who underwent TKA had increased rates of major complications (PE, DVT, MI, post-operative I&D, respiratory failure) within 90 days after surgery, while the morbidly obese were 3 times more at risk of developing major and minor (UTI, renal failure, blood transfusion, stiffness) complications. Morbid obesity was associated with increased rates of local complications when compared to those who were obese or not obese, medical complication frequencies were also significantly higher in the morbidly obese versus the obese. Meller et al. (2016) added additional evidence with a cited relationship between rising BMI and the risk of developing renal failure

after total joint replacement. Si et al. (2015) provided further medical complication evidence when it was reported the rate of deep vein thrombosis increased amongst their morbidly obese population undergoing TKA. There is a clear correlation throughout the articles reviewed that a BMI of greater than 40 has a significant effect and correlation on the risk of developing medical complications after total joint arthroplasty (Alvi et al., 2015; Kandil et al., 2015; Meller et al. 2016; Shohat et al., 2015; Si et al., 2015).

Alvi et al. (2015) indicated that a BMI greater than 40 puts a morbidly obese patient at an increased risk of complications post total joint arthroplasty when compared to normal weight and overweight patients. Pugely et al. (2015) cited that a BMI greater than 40 was linked with a odds ratio of 1.9 risk of higher complications post total joint arthroplasty. The stratified risk of infection, medical complications, and surgical complications correlated throughout the literature adds additional negative outcomes on the morbidly obese patient undergoing total joint replacements. Morbidly obese patients receiving total joint arthroplasty were also associated with increased cost related to their increased morbidity (Meller et al., 2016). These associated costs are highlighted through the literature and are due to higher rates of readmission, infection, complications, and component failures. Meller et al. (2016) reported that morbidly obese total joint patients are 15% more likely to return to the hospital within 90 day after their operation. With the documented complications and risks it is not a surprise when Sayer-Noor et al. (2019) documented that a BMI of greater than 40 had higher mortality rates at the 90-day mark after total joint arthroplasty.

Evidence found throughout the literature consistently reveals the poor clinical outcomes associated with those patients undergoing total joint replacement with a concurrent BMI greater than 40. A BMI greater than 40 was connected to medical complications, surgical complications,

and surgical site infection when compared to BMI less than 25 and overweight individuals (Alvi et al., 2015). Currently, there is no standard threshold amongst the orthopedic community on body mass index and total joint arthroplasty. There is a clear correlation with higher risk of infection, medical complications and surgical complications such as the need for revision or reoperation in the morbidly obese population undergoing total joint arthroplasty. Shohat et al. (2018) stated the BMI greater than 40 group had a threefold increased risk of complications thus benefits and risks must be measured in this group in regards prior to surgery. With this in mind Pugely et al. (2015) suggested surgeons discuss with obese patients these risks and caution elective surgery. The orthopedic surgeon should have an honest discussion with the morbidly obese patient about risks and benefits of the surgery.

The literature provides well documented ill effects of raising BMI associated with poor clinical outcomes in total joint arthroplasty patients. This provides an opportunity for further research on what the optimal BMI to perform joint replacements, as the max threshold (BMI of 40) for detrimental outcomes has been concluded in the literature. More research is needed on total hip arthroplasty and the effect of body mass index, as many of the studies were dominated by total knee arthroplasty. Ultimately, a body mass index of greater than 40 does correlate with poor clinical outcomes in total joint arthroplasty patients and can serve as a threshold to help guide the patient and surgeon on determining the risks and benefits of total joint arthroplasty.

Learning Points

- Obesity is a risk factor for the development of osteoarthritis. Those who are obese are at an increased risk to need a joint replacement while being at danger of complications and worse outcomes post-surgery. Those who are obese also have

co-existing comorbidities which influence surgery and healing, this only adds further complication risks and increased risks to surgery.

- As BMI increases so does the risks of undergoing total joint arthroplasty. The peak of the complications rises at the threshold of BMI greater than 40. These complications include higher rates of infection (superficial, deep, or prosthetic), revision, reoperation, mechanical failure, medical complications, and surgical complications. There is agreement amongst the evidence linking the risk of infection to a body mass greater than 40 in patients undergoing total joint arthroplasty.
- A body mass index of greater than 40 does correlate with poor clinical outcomes in total joint arthroplasty patients and can serve as a threshold to help guide the patient and orthopedic surgeon on determining the risks and benefits of surgery.
- More research is needed on total hip arthroplasty and the effect of body mass index, as many of the studies were dominated by total knee arthroplasty. If a BMI of greater than 40 is correlated with poor clinical outcomes, further research is needed to find the appropriate BMI threshold correlated with the best outcomes for total joint replacements in obese patients.

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Appendix: Case Report

T. Smith is a 46-year-old female patient with a history of hypertension, obesity, diabetes type 2, hypothyroidism, and squamous cell skin carcinoma. She presents for a preoperative exam for right knee arthroscopy for meniscal tear. She fell six months ago which caused injury to the right knee. She reports this was just an accident when she slipped and fell, no medical cause for the fall. She has been doing well since the injury but still is having pain with activity to the right knee. She has been using ibuprofen 600mg TID and Tylenol 1000mg TID for her pain. There is no numbness or tingling to the right lower extremity, nor to her other extremities. She denies any weakness or the knee giving out. She denies any recent illness. She denies fevers, sore throat, or cough. She denies shortness of breath, chest pain, or palpitations. Denies leg swelling. There has been no recent nausea, vomiting, or diarrhea. No concerns with her bowels or urination. She denies rash. She reports she does not check her blood sugars or blood pressures, though previously they have all been well controlled. She also reports her thyroid has remained within normal limits in the past.

She reports she is able to climb several flights of stairs with no issue along with walk several city blocks with no shortness of breath or chest pain. She does not do any particular exercise program but reports she does stay active with walking. She is a former 1 pack per day smoker for 20 years which she quit several years ago and rarely drinks. No illicit drug use. She has tolerated surgery and anesthesia well in the past with a previous hysterectomy and two c-sections. She denies a history of bleeding or clotting tendencies. No adverse events to anesthesia in her family history.

T. Smith reports she is on Lisinopril 10mg, ASA, Metformin 1000mg BID, Rybelsus 7mg daily, Aspirin 81mg daily, and Synthroid 125mcg. She has taking Tylenol and Ibuprofen as

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needed for pain. She is tolerating these medications well, and reports her blood pressure, blood sugar, and thyroid have been well controlled. She is unsure what her last A1C was. She is allergic to amoxicillin and morphine. Her pertinent family history includes a father who has a history of coronary artery disease with three stents at age 55 along with hypertension and hyperlipemia. Her mother suffers from hypertension, obesity, and breast cancer at 60. Her brother and sister are doing well and in good health.

Once a history was obtained from T. Smith a comprehensive physical exam was completed. T. Smith's vital signs at the visit included: BP 136/88, HR 78, RR 16, Temp 98.5 F, and 95% oxygen saturation. Today she weighs 211 pounds with a BMI of 34. She is a pleasant 46-year female who is alert and oriented with proper gait. Her pupils are equal, round, and reactive to light, upon fundoscopic exam there is a red reflex bilaterally with clear fundi and no arteriovenous nicking or retinopathy. Her tympanic membranes are normal bilaterally. Her thyroid is nonpalpable, there is no cervical adenopathy. Her posterior pharynx is clear with no drainage or tonsillar hypertrophy. Her Mallampati class would be considered a I, there are no missing teeth, nor does wear dentures. She can open her mouth to 3-4 finger breadths and has full range of motion to her neck. Her cardiac assessment reveals a normal heart rate and rhythm, S1 and S2 were heard with no extra heart sounds, murmurs, rubs, or gallops. There are no carotid bruits or thrills. Her radial, tibial, and dorsalis pedis pulses are equal and plus +2 bilaterally. There is no jugular venous distention or peripheral edema. Her respiratory exam reveals clear lung sounds to auscultation that are even with non-labored respirations. Her abdominal exam reveals a soft, non-distended, and non-tender abdomen with normal bowel sounds. Her neurologic exam discloses cranial nerves are 2-12 intact and normal, she has full equal sensation and strength to all four extremities. There is no rash or wound to her skin. The

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right knee shows no redness, swelling, and is non tender. Diabetic foot exam reveals some callousing to her heels with no wounds with normal monofilament testing to her bilateral feet.

With her history of diabetes, obesity, hypertension, and hypothyroidism along with her father having a cardiac event and stents at 55 we did perform several pre-operative labs today which are as follows: TSH 3.65, a BMP which was within normal limits, notable a creatinine of 0.8, glucose 98, albumin 3.9, and potassium 4.0, a normal CBC including a hemoglobin of 14.6, prior A1C's have been well controlled per patient, and a EKG showing normal sinus rhythm.

T. Smith's revised cardiac risk index for preoperative risk is a class 1 risk. Her ARISCAT score for postoperative pulmonary complications is low risk. She is able to meet greater than 4 METS. Therefore, her functional capacity is well. Based on T. Smith's medical history, tolerance of previous surgery, physical exam, and lab results we will clear her for surgery and confirm her as a low- moderate risk for surgery. Educated to follow her orthopedic surgeon instructions on medications. She is okay to take her daily medications but should stop taking ibuprofen and her aspirin 5-7 days prior to surgery, Tylenol is okay. She is instructed to avoid any new supplements as well. She is agreeable to this plan. She may continue to use her medications post operatively, she may have to avoid her ibuprofen, but her aspirin could provide benefit for DVT prophylaxis. She should follow the instructions of her orthopedic surgeon.

In regard to a plan and recommendations, we did discuss T. Smith's weight today. T.Smith's BMI is 34 classifying her as obese. We discussed the risk factor of obesity with the incidence of osteoarthritis leading to the need of a total joint replacement in the future (Springer et al., 2013). Per Springer et al. (2013) obese patients with a BMI greater than 30 have an increased risk of perioperative complications and this risk should be addressed with the patient before contemplating total joint replacements. If T.Smith's BMI was to increase to greater than

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40 threshold the perioperative implications will only increase such as infection, questionable functional improvements, and increased revision rates (Springer et al., 2013). T. Smith is open to this discussion. She is willing after her meniscus repair to start physical therapy and achieve regular exercise of at least 30 minutes five days a week once she is healed. We did discuss the idea of a referral to the diabetic educator and weight management program to initiate weight loss. She is open to both of these referrals; we did place them today. We will follow up 2 months after surgery to make sure she is getting on track with these referrals and to ensure she is rehab. Encouraged her to start tracking her blood pressures, blood sugars, and weights. Continue her medication regimen. She will contact the clinic sooner for any issue at all. She is agreeable to the plan and all questions answered.