Predictive Factors in Selecting Patients with Knee Osteoarthritis for Knee Replacement: A Single Center Experience

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ABSTRACT

Total knee arthroplasty (TKA) is gaining acceptance among patients worldwide, knowing who benefits from surgery and who does not is detrimental. Comorbid conditions are detrimental for joint replacement surgery, and patient medical optimization is critical and sometimes challenging. TKA surgery was first performed in 1968. Since then, improvement in many aspects of the procedure is reported. This study aimed to retrospectively evaluate the predictive factors for outcome in TKA done at Aseer central hospital. Retrospective study of TKA cases done at a tertiary care hospital in the Abha region, Saudi Arabia from January 2006 to January 2012 was included in the study. Knee function was evaluated using Knee Society scoring system and the percentage of each comorbidity in our study's patient was recorded. In our study group there were more females (83.33%) than males (16.67%) Whereas, comorbidities and their frequencies in the study group were: psychosocial factors (28.4%); severe joint disease (67%); additional joint disease (other knee, 59.4%; hips, 35.4%; spine, 34.2%); depression and anxiety (49.8%); hypertension (25%); asthma (14%); sleep apnea (8.4%); diabetes: HbA1c < 7 (82%); HbA1c > 7 (18%); obesity BMI < 30 (96.6%); BMI > 30 (3.4%); peripheral vascular disease (0.20%). Furthermore, comparative pre- and postoperative knee scores with observed correlation showed significant improvement. Isolating the predictive factors of unfavored outcome may help total knee results.

Keywords: Total knee arthroplasty, Saudi Arabia, osteoarthritis, predictive factors, knee scores

INTRODUCTION

Total knee arthroplasty (TKA) is gaining worldwide acceptance among patients thus, care must be exercised when treating end-stage knee arthritis to decide which patient will benefit most from surgery and which patient is best treated conservatively [1]. Comorbid disorders are a pathognomonic for joint replacement surgery, and patient medical optimization is crucial, but often difficult. In 1968, the first knee replacement operation was conducted [2]; since then, improvements in surgical materials and techniques have significantly increased its effectiveness. Total knee replacement is one of the most successful surgical procedures, and according to the Agency for Healthcare Research and Quality [3], more than 600,000 knee replacements are performed annually in the United States. In the United Kingdom, approximately 35000 patients undergo total knee replacement annually [3]. In the Middle East, including Saudi Arabia, the yearly number of knee replacements has increased substantially in recent years. The increased survival and high success rate in the past have been low [4]. To study our patient selection for knee replacement, we retrospectively evaluated our experience in a tertiary hospital in southwestern Saudi Arabia to determine the predictive factors for patients who will benefit the most from knee replacement.

METHODOLOGY

Participant Characteristics: This retrospective cohort study included all patients who underwent knee replacement in a tertiary care hospital (Aseer Central Hospital) in southwestern Saudi Arabia from January 2006 to January 2012.

Sampling Procedures: History and physical examination were thoroughly performed and documented. Standard plane radiographs (weight-bearing anteroposterior, lateral, and skyline views) were obtained for all patients to assess the severity of local knee changes, as well as bone stock and pelvis plain/lumbosacral radiographs in selected cases to evaluate other joint diseases. Historically, we documented patient status with regard to diabetes, hypertension, rheumatoid arthritis, asthma, and active septic foci, such as urinary tract infection and dental abscess, to treat and optimize patient conditions accordingly. Routine preoperative laboratory investigations, including CBC, PT prothrombin time, APTT activated partial thrombin time/ INR international normalized ratio, ABO blood grouping, urea, and electrolytes. Other laboratory investigations were added according to any pre-existing medical conditions such as glycated hemoglobin HBA1C in patients with diabetes, and other tests or investigations were requested as needed.

Body mass index (BMI) was measured in all patients, and preoperative consultation was performed to optimize the patient's condition. Preoperative informed consent was obtained from all patients. Patients usually provided preoperative instructions to prepare them for surgery, as well as preoperative cardiac anesthesia to assess the surgery risk and to help determine the mode of anesthesia. Patients also received other selected specialties such as endocrinology consultation to ensure that they are optimized and given the required instructions, including when to stop certain medications, and which preoperative medication to continue. Physical therapy assessment before surgery was required in selected cases.

Surgical Procedure: All patients cleared for surgery were admitted overnight and fasted for a minimum of 6 h before surgery. Prophylactic antibiotics were administered intravenously with induction of anesthesia in case of general anesthesia or before Foley's catheter insertion if the spinal/epidural mode was chosen by the anesthesiologist (ceftriaxone, 1 g) is given intravenously an addition of gram-negative coverage antibiotics was performed selectively. Tranexamic acid (20-30 mg/kg) was given 45 min before surgery to reduce the intraoperative blood loss and reduce the need for blood transfusion.

All surgeries were performed through a midline incision (8–13 cm) with medial parapatellar arthrotomy. Synovectomy was performed

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in cases with hypertrophied synovium, including cases of pigmented villonodular synovitis where histological specimens were sent. The knee was fully flexed with patella which was either averted or laterally sided, the osteophytes were removed and a cemented posterior-stabilized knee system was used in all cases (Figure 1). From this system, the cruciate ligaments were removed as well a intra-articular degenerative remnant of menisci along with loose bodies so as to prepare for standard posterior stabilized knee bone cuts by using an intramedullary femoral guide and an extramedullary tibial guide. Moreover, a drain was used in all the cases and then removed when less than 100cc was collected over 24 hours or within 48 hours maximum. The surgery lasted for 90-120 minutes.

Figure 1: Intra operative image showing standard medial parapatellar arthrotomy, patella eversion, and posterior stabilized knee implants

Postoperative Care: A compressive Johns bandage dressing and ice were applied to the knee to relieve pain and decrease postoperative bleeding for the first 24 h. The postoperative management protocol included 1–3 days of prophylactic antibiotic administration according to patient comorbidities. Pain management included 1g of perfargan intravenously as required every 6 h and pethidine 50– 75 mg intramuscularly as required every 6 h. Antithrombotic medications with enoxaparin subcutaneously (40 mg) during admission once daily, and then Xarelto (rivaroxaban) tablets (10 mg) were administered for 2 weeks. Later, aspirin (81 mg) was administered orally until the patient became physically active postoperatively. Postoperative radiography was performed before the patients were discharged home.

Continuous passive motion was initiated for all patients, with the exception of patients in whom subcutaneous fat was noted to be abundant to avoid wound leakage. Physiotherapy, including static quadriceps muscle, active straight leg raising, and crutches, was started on postoperative day 1. Weight-bearing mobilization with the walker was started on day 2. Discharge occurred 5–7 days after the operation.

Follow-Up: During the follow-up period, sutures were removed 2 weeks after the operation, at which point, the patients started physiotherapy for 6 weeks. The follow-up period lasted for 3 months, followed by 6 months to 1 year. Annual follow-up with clinical and radiological examinations was performed. All patients were evaluated using the Knee Society Score, which is divided into knee and knee functional scores [5]. We have compared our selection criteria to the established guidelines in the literature regarding the outcome predictive preoperative factors shown in Table 1. This helped us to delay some patients to provide better optimization or to counsel them against knee replacement. These factors are numerous and vary from local joint factors to systemic patient well-being and habitual behaviors, such as smoking.

Statistical Analysis: Statistical analysis was performed to determine the significance of the observed data using significance tests such as

Table 1: Allocation the sociodemographic data for obese adult clients

Category	Frequency (Very frequent/ infrequent)	Preoperative optimization		Prevalence	p-value
		Yes/no	**Advice/ therapy**		
Psychosocial factor	Infrequent	Yes: most patients reported "anxiety" and were receiving treatment	Counselling was provided	28.40% (n = 142)	< 0.0001
Severe joint disease	Frequent	N/A	N/A	67% (n = 335)	0.001
Additional joint disease	Frequent - another knee	N/A	N/A	Other knee-59.40% (n = 297)	< 0.0001
	Infrequent - hips and spine			Hips: 35.40% (n = 177) and Spine: 34.20% (n = 171)	< 0.0001
Mental health	Frequent (Depression, anxiety)	Yes	Psychiatric consultation was provided	49.80% (n = 249)	< 0.0001
Cardiac disease	Frequent (hypertension)	Yes	Cardiac evaluation and consultation were provided	25% (n = 125)	< 0.0001
Respiratory disease	Infrequent (asthma/sleep apnea)	Yes	Pulmonary evaluation and consultation were provided	Overall: 22.40% (n = 112)	< 0.0001
				Asthma: 14.0% (n = 70) Sleep apnea: 8.40% (n = 42)	< 0.0001
Diabetes	HbA1c < 7	Yes		82.0% (n = 410)	< 0.0001
	HbA1c > 7			18.0% (n = 90)	
Obesity	Frequent: BMI < 30	No	Dietary consultation/ counselling was provided	BMI< 30: 96.60% (n = 483)	< 0.05
	Infrequent: BMI > 30			BMI>30: 3.40% (n = 17)	
Peripheral vascular disease	Infrequent	No	Consultation with vascular surgeon was provided	0.20% (n = 1)	
Smoking	Infrequent	No	Counselling was provided	0% (n = 0)	

the chi-square test and Fisher's exact probability test. Other indicative parameters calculated were rates, odds, risk ratio (95% confidence interval [CI]), and odds ratio (with 95% CI). Pearson correlation was determined between the pre-and postoperative knee scores. IBM SPSS Statistics for Windows, (version 19.0. Armonk, NY: IBM Corp.) was used to perform all statistical analyses.

2.5 Ethical Approval: The Ethical Committee of King Khalid University approved the study (ECM#2020-205) -(HAPO-06-B-001).

FINDINGS AND DISCUSSION

Between January 2006 and January 2012, 500 patients who underwent primary cemented knee replacement in a tertiary care hospital (Aseer Central Hospital) in southwestern Saudi Arabia were included in this retrospective cohort research (Figure 2). The patients ages ranged from to 60–85 years, with an average age of 72.5 years. Females were predominant, with 83.33%, and 16.67% of the included patients were males. The associated comorbidities in the study group were as follows: psychosocial factors (28.4%); severe joint disease (67%); additional joint disease (other knee, 59.4%; hips, 35.4%; spine, 34.2%); depression and anxiety (49.8%); hypertension (25%); asthma (14%); sleep apnea (8.4%); diabetes: HbA1c < 7 (82%); HbA1c > 7 (18%); obesity BMI < 30 (96.6%); BMI > 30 (3.4%); and peripheral vascular disease (0.20%) (Table 1). All patients had osteoarthritis, either degenerative or secondary to trauma, in their knees; 330 patients, with osteoarthritis on the right side and 170 patients with osteoarthritis on the left side. Primary cemented cruciate-substituting total knee replacement was performed. The same orthopedic surgeon performed a subsisting-knee replacement. The duration of symptoms ranged from 5–10 years.

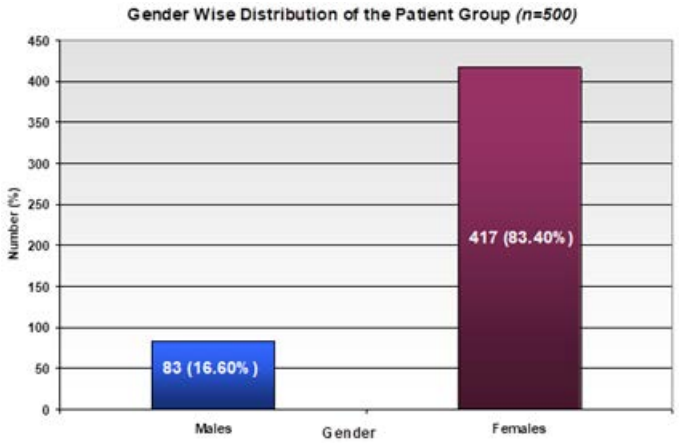

Figure 2: Gender-wise distribution of the patient group

The underlying pathology of osteoarthritis is mostly senile, while in younger patients, it is secondary to trauma or a relative increase in BMI. Most surgeries were performed on the right side (291 patients, 58.2%), while the left side was performed in 209 patients (41.8%). A significant component of the knee score, being pain, markedly improved after TKA. The preoperative pain score was 13.03 points, while the postoperative pain score was 45.15 points. The range of motion was also considerably enhanced. The mean preoperative range of flexion of the knee was 85°, while the mean postoperative range of flexion was 100°. The mean knee scores and functional scores improved significantly, as shown in Table 2. Uniformly poor knee scores were observed preoperatively and improved postoperatively, with excellent results in 452 patients (90.4%), good in 38 patients (7.6%), fair in 7 patients (1.4%), and poor in 3 patients (0.6 %). Good and excellent results were achieved in 98% of the cases (490 of 500 knees). Knee scores were obtained by patients answering Oxford knee score questions preoperatively and comparing each patient's score 6 weeks postoperatively after completing physiotherapy; two knees (0.4%) were excellent, two knees (0.4%) were good, 25 knees (5%) were fair, and 471 knees (94.2%) were poor (Table 2).

Walking preoperatively was, in late cases, difficult and painful, which improved postoperatively, leading to a significant improvement in the capability of climbing stairs after knee replacement. The need to use a cane or walking stick for assistance while walking improved as well following surgery. The Timed Up and Go Test (TUG) is a performance-based measure of activity tests that assesses how long it takes a patient to rise from an armed chair of seat height of 46 cm and walk 3 m, turn and return to the same chair for sitting. We also noticed that an improvement in the 6-min walk test was a timed test that measured the extent to which patients could walk on a level surface in 6 min. If necessary, patients were allowed to use an assistive device, and they were asked to cover as much distance as possible with rest as needed. Concerning physical impairment measures, the pain was measured using the bodily pain scale from the SF-36 Health Survey. In our patients, preoperative low scores improved to high scores postoperatively in the majority of patients. Intractable knee swelling preoperatively reduced postoperatively as the patient started physiotherapy. Finally, the documentation of a functional range of motion measured using standard long-arm goniometry showed that our patients had a functional range of motion.

The most common complications in our patients were superficial infection in two patients (Figure 3), both of whom responded well to intravenous antibiotics; traumatic patellar dislocation in two patients, who were treated conservatively; periprosthetic fracture around the tibia tray in two patients, one fracture distal to the tray secondary to a missed stress fracture fixed intraoperatively with plate and screws in the second case with displaced cortical fracture which was followed and healed; early deep infection within the first 3 weeks postoperatively in two patients treated with exchange liner and wash out; and one patient with late septic joint requiring two-stage revision. Figure 4 shows the bony erosion and ligamentous laxity, and Figure 5 shows a well-balanced postoperative X-ray image.

The documented benefits of knee replacement in treating patients with end-stage knee osteoarthritis should not distract surgeons from the severe complications and low patient satisfaction associated with the surgery. As a result, it's critical to emphasize the importance of identifying patients who will benefit most from knee replacement and those who should be treated conservatively based on predictive patient selection criteria, which are based on the patient's medical history, physical examination, and radiological changes. These changes confined to the knee joint are reflected as intractable pain, reducing the activity of daily living, which becomes painful at night and increases patients' need for pain medications, potentiating improvement from surgery, and justifying the risks. The patient's minimum physical strength of the quadriceps is another local knee factor.

Weight-bearing plain radiographic evidence of advanced knee osteoarthritis, among other signs, includes instability, stiffness and deformity, which worsen symptoms (Figure 4) preoperatively and predict favorable outcomes and justify risks. However, a high correlation has yet to be established [6]. According to the United Kingdom National Institute for Health and Care Excellence guidelines, the symptoms should also be "prolonged and established" to protect those with transient symptoms or acute exacerbations against surgery [7].

Table 2: Comparative pre- and post-operative knee scores with observed correlation

Knee scores	Pre-operative knee scores			Post-operative knee scores		
	Males [n (%)]	Females [n (%)]	Total [n (%)]	Males [n (%)]	Females [n (%)]	Total [n (%)]
Excellent	1 (0.20%)	1 (0.20%)	2 (0.40%)	66 (13.20%)	386 (77.20%)	452 (90.40%)
Good	1 (0.20%)	1 (0.20%)	2 (0.40%)	13 (2.60%)	25 (5.00%)	38 (7.60%)
Fair	12 (2.40%)	13 (2.60%)	25 (5.00%)	3 (0.60%)	4 (0.80%)	7 (1.40%)
Poor	69 (13.80%)	402 (80.40%)	471 (94.20%)	1 (0.20%)	2 (0.40%)	3 (0.60%)
Total	83 (16.60%)	417 (83.40%)	500 (100%)	83 (16.60%)	417 (83.40%)	500 (100%)
Chi-Square [p-value]	22.32 (< 0.001)			13.90 (< 0.01)		
Pearson correlation: Pre- and post-operative knee scores				–0.51395	–0.37659	–0.39582
Pre-operative compared with post-operative knee scores						
Male group chi-square [p-value]				144.803 (< 0.00001)		
Female group chi-square [p-value]				805.969 (< 0.00001)		

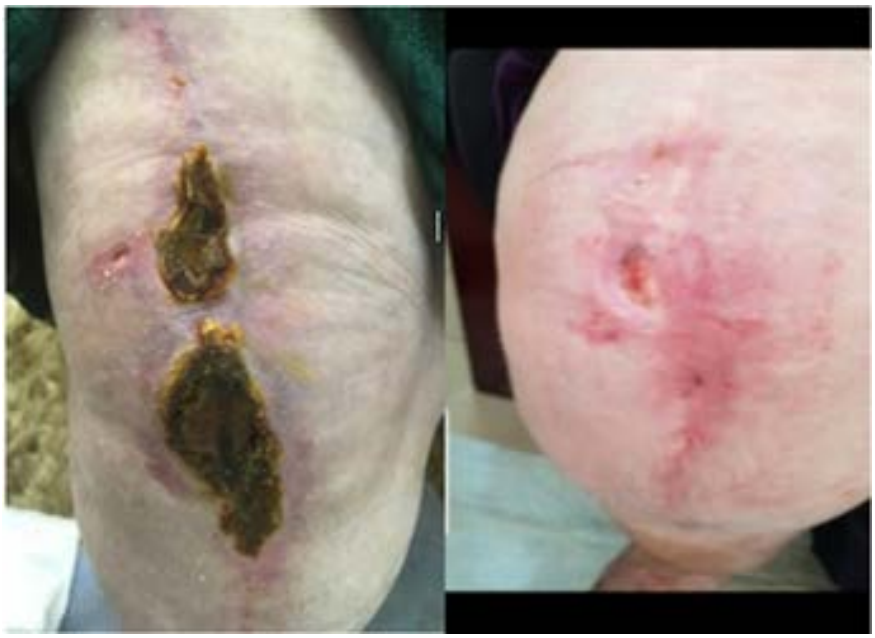

Figure 3: Example of poor wound healing in an obese patient with uncontrolled diabetes

Figure 4: Example of bony erosion and ligamentous laxity

Figure 5: Well-balanced postoperative X-ray

Non-operative treatments such as pain medication, physiotherapy, walking assist devices, and patient education, including weight loss, should be offered where possible as these can help to reduce pain, improve function, and delay the need for knee replacement. Conservative treatment for osteoarthritis is accessible and has been thoroughly reported by various authors, with a variable evidence basis [8]. Recognizing specific prognostic indicators for success aided in the choice to give surgery. When prosthesis selection and surgeon training are taken out of the equation, only the patients' general characteristics or local changes in the knee joint are found to be deleterious to knee replacement surgery. Patients who are younger and those who are above 90 years have a higher revision surgery rate [9,10].

However, younger age is not a contraindication for knee replacement, provided that other indications are satisfied. Elderly patients with extreme age show lower rates of revision compared to younger patients [11]. The extreme age of patients and comorbidities is high among them, which is a challenge for their required preoperative optimization and increases their intraoperative, short postoperative, and late complications. Men also have a higher revision rate after knee replacement, primarily due to a higher infection rate in the Australian registry Association, 2010. Studies have displayed a lower patient-reported satisfaction in women; however, this finding is inconsistent [12, 13]. Evidence suggesting sex as a significant determinant of suitability for surgery is insufficient. Mental disturbance and pain response abnormalities correlate well and strongly predict postoperative pain persistence [14, 15]. Although this carries implications for patient selection, the evidence is low. There is no evidence available to label mental health problems [16] as a predictor of knee replacement outcome, despite concerns of its effect, no clinical and patient-reported results can be achieved compared in to the effect of common comorbidities such as diabetes [17] and obesity [18], including people with multiple comorbidities of varying severity [19].

The severity of osteoarthritis before surgery correlates well with surgical reasons and has been used as a significant predictor of knee replacement; the greater the severity, the more positive the procedure's projected [20]. However, the severity of changes does not necessarily correlate with the symptoms, which explains why some patients with less severe preoperative symptoms have less room for improvement. Offering knee replacement requires sufficient symptoms and explainable pathology that is correctible, and the failure of less risky alternatives to indicate absolute contraindications for knee replacement, such as active knee joint infection. Other absolute contraindications included acute cardiovascular events. Relative contraindications include significantly shortened life expectancy due to comorbidities, very high BMI (≥40), history of prior infection of the knee joint, increased risk of disease, enhanced preoperative risk, physical comorbidity, psychological/ psychiatric comorbidity, ingestion of drugs that increase the risk of surgery, substance addiction, and neurological disorders. The decision for surgery is based on the balance of the relative risks and benefits [21]. Patients with mild to moderate osteoarthritis should be offered conservative treatment [21], and it improves the functional status of the patients.

The most common cause of mortality in patients with knee replacement remains to be cardiac disease, and previous myocardial infarction and heart failure [22] are most strongly associated with mortality. The surgical procedure (with TKA classified as intermediate risk from an anesthetic point of view), where assessment of functional capacity (using a simple questionnaire to identify metabolic equivalent tasks), and evaluation of specific cardiac risk factors is performed in conjunction with a cardiology consultation [23]. Heart failure and valvular heart disease, especially aortic stenosis, represent the highest risk of perioperative cardiac morbidity, and those affected should be referred for specialist assessment [24]. Perioperative protocol-driven prevention of acute kidney injury is also important in this patient group, and is based on careful fluid management, vasopressors, and inotropes when indicated, and the use of blood products [25].

Rarely, severe respiratory complications can be common causes of readmission or mortality postoperatively. Obstructive sleep apnea is of particular concern because it is often undiagnosed in surgical patients [26] and is a risk factor for severe complications and the requirement for ventilator support secondary to opioid-induced respiratory depression [27]. Using evidence from a series of systematic reviews, detailed guidelines regarding the perioperative assessment of pulmonary disease in surgical patients are available [28]. Several evidence-based risk factors for respiratory problems are identified in the guidelines (age > 60 years, chronic obstructive pulmonary disease, American Society of Anesthesiologists physical status ≥ grade 2, functional dependency, and heart failure) [29]. Patients with risk factors should be assessed by preoperative chest radiograph and spirometry where obstructive pulmonary disease is present. There is good evidence from randomized controlled trials in patients with risk factors that incentive spirometry may reduce postoperative complications following non-thoracic surgery [30]. Moderate to severe obstructive sleep apnea may be identified with high accuracy using the STOP-Bang Questionnaire [31]. Narcotic medication should be avoided in at-risk patients, and careful postoperative monitoring is required [32]. Impaired wound healing, inadequate bone healing capacity, and reduced immune defense mechanisms make uncontrolled diabetes a predictor of poor outcomes of knee replacement [33].

The significantly higher risk of moderate to severe functional impairments in diabetic patients at 2 and 5 years after knee replacement is explained by the observed increased incidence of deep infection, deep vein thrombosis, and aseptic loosening [34]. Furthermore, preoperative blood sugar and HbA1c abnormalities, when paired with characteristics such as evidence of patient self-monitoring ignorance and the presence of diabetes comorbidities, raised the likelihood of multiple adverse events significantly [35]. If issues during and after surgery are to be avoided, referral to a specialty team early enough in the preoperative period will be required.

Obesity is a global problem and a significant health problem in Saudi Arabia, with 33% of the population affected, with increasing rates [36]. Moreover, it has been reported that one in four Canadians are obese, resulting in increased incidence of comorbidities such as

diabetes, hypertension, and coronary artery disease, which contribute to the development and severity of symptomatic knee arthritis [37]. Inconsistent reports have revealed that obesity harms the knee replacement outcome by increasing complications, reducing implant survival, and increasing knee replacement cost [38]. Although obese individuals are reported to benefit from knee replacement, a BMI > 45 should be considered a contraindication for knee joint replacement. Despite this, surgeons' practice and interpretation of morbid obesity differ, as some surgeons do not consider weight localized to the truncal area-sparing limbs a contraindication. They argue that this does not compromise patient preoperative optimization and should not prevent knee replacement when needed. Weight loss-counseling is of great importance and should be encouraged to patients as a treatment for their life-threatening condition if their obesity is associated with severe comorbidity and involves the limb making the procedure challenging and local complications more likely. Moreover, bariatric surgery for early knee pain results in significantly decreased knee damage, stiffness, and improved function [39].

Due to profound vascular disease a strong predictor of negative outcome for knee replacement, as well as bring risk factor for deep infection, wound healing problems, and catastrophic arterial injury after TKA is identified as compromised peripheral circulation. The American Academy of Orthopedic Surgeons [35] suggested an assessment of peripheral vascular disease risk, including current symptoms, history of vasculopathy, and evaluation of pulses. Moreover, an ankle-brachial pressure index should be obtained in at-risk patients, and an index < 0.9 should trigger a referral for vascular assessment and possible intervention before TKA. The use of an intraoperative tourniquet is generally not recommended [40].

Smoking has been shown to significantly affect knee replacement outcomes, and is associated with increased complications and mortality [41]. Stopping smoking before [42] and up to 6 months following knee replacement provides the highest chance of success and reduces postoperative complications. Therefore, patient counseling should also include information about the risks of smoking on knee replacement.

CONCLUSION

Aside from being a single-center study, the main limitation of this study is that we included all possible factors that may influence total knee replacement outcome, whereas focusing on a smaller number of factors would have improved the results. The level of evidence is low in the available literature regarding presumed predictive outcome factors. Thus, preoperative interventional trials aiming to improve knee replacement outcomes are needed to increase the available evidence for multiple predictive factors associated with comorbidities or patient behavior. In this study we found that identifying patient comorbidities helps improving total knee replacement patients.

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Competing Interest: None.

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REFERENCES

1. Crawford DC, Miller LE, Block JE. Conservative management of symptomatic knee osteoarthritis: a flawed strategy? Orthop Rev (Pavia) 2013;5(1): e2.
2. Ranawat AS, Ranawat CS. The history of total knee arthroplasty. The knee joint. Paris, Springer 2012; 99-707.
3. Moran CG, Horton TC. Total knee replacement: the joint of the decade A successful operation, for which there's a large unmet need. BMJ 2000;320(7238):820.
4. Ahlberg A. Knee joint replacement in Saudi Arabia-present and future. ASM 1994;14(4):281-2.
5. Theodoulou A, Bramwell DC, Spiteri AC, et al. The use of scoring systems in knee arthroplasty: a systematic review of the literature. J. Arthroplasty 2016;31(10):2364-70.
6. Bedson J, Croft PR. The discordance between clinical and radiographic knee osteoarthritis: a systematic search and summary of the literature. BMC Musculoskelet Disord 2008;9(1):1-1.
7. UK. National Clinical Guideline Centre. Pharmacological management of osteoarthritis. In Osteoarthritis: Care and Management in Adults. National Institute for Health and Care Excellence (UK), 2014.
8. McAlindon TE, Bannuru R, Sullivan MC, et al. OARSI guidelines for the non-surgical management of knee osteoarthritis. Osteoarthritis cartilage 2014; 22(3):363-88.
9. Aggarwal VK, Goyal N, Deirmengian G, et al. Revision total knee arthroplasty in the young patient: is there trouble on the horizon? J Bone Joint Surg Am 2014;96(7): 536-42.
10. Bayliss LE, Culliford D, Monk AP, et al. The effect of patient age at intervention on risk of implant revision after total replacement of the hip or knee: a population-based cohort study. Lancet 2017;389(10077):1424-30.
11. Haynes J, Sassoon A, Nam D, et al. Younger patients have less severe radiographic disease and lower reported outcome scores than older patients undergoing total knee arthroplasty. Knee 2017;24(3):663-9.
12. Baker PN, Deehan DJ, Lees D, et al. The effect of surgical factors on early patient-reported outcome measures (PROMS) following total knee replacement. J Bone Jt Surg 2012;94(8):1058-66.
13. Heo SM, Naylor JM, Harris IA et al. Reliability of patient-reported complications following hip or knee arthroplasty procedures. BMC Med Res Methodol 2019;19(1): 1-8.
14. Blakeney WG, Epinette JA, Vendittoli PA. Dual mobility total hip arthroplasty: should everyone get one? EFORT Open Rev 2019;4(9):541-7.
15. Baker PN, Van der Meulen JH, Lewsey J, et al. The role of pain and function in determining patient satisfaction after total knee replacement: data from the National Joint Registry for England and Wales. J. Bone Jt Surg 2007;89(7):893-900.
16. Blackburn J, Qureshi A, Amirfeyz R, et al. Does preoperative anxiety and depression predict satisfaction after total knee replacement? Knee 2012;19(5):522-4
17. Magone K, Kemker III BP, Pilipenko N, et al. The new surgical technique for improving total knee and hip arthroplasty outcomes: patient selection. J Arthroplasty 2017;32(7):2070-6.
18. Singh JA, O'Byrne M, Harmsen S, et al. Predictors of moderate–severe functional limitation after primary Total Knee Arthroplasty (TKA): 4701 TKAs at 2-years and 2935 TKAs at 5-years. Osteoarthr Cartil 2010;18(4):515-21.
19. Schilling CG, Dowsey MM, Petrie DJ, et al. Predicting the long-term gains in health-related quality of life after total knee arthroplasty. J Arthroplasty 2017;32(2):395-401.
20. Stone OD, Duckworth AD, Curran DP, et al. Severe arthritis predicts greater improvements in function following total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2017; 25(8):2573-9.

21. Fransen M, McConnell S, Harmer AR, et al. Exercise for osteoarthritis of the knee: a Cochrane systematic review. Br J Sports Med 2015;49(24):1554-7.
22. Bozic KJ, Lau E, Kurtz S, et al. Patient-related risk factors for postoperative mortality and periprosthetic joint infection in medicare patients undergoing TKA. Clin Orthop Relat Res 2012;470(1):130-7.
23. Kristensen SD, Knuuti J, Saraste A, et al. 2014 ESC/ESA Guidelines on non-cardiac surgery: cardiovascular assessment and management: The Joint Task Force on non-cardiac surgery: cardiovascular assessment and management of the European Society of Cardiology (ESC) and the European Society of Anaesthesiology (ESA). Eur Heart J 2014;35(35):2383-431.
24. Priebe HJ. Preoperative cardiac management of the patient for non-cardiac surgery: an individualized and evidence-based approach. Br J Anaesth 2011;107(1): 83-96.
25. Brienza N, Giglio MT, Marucci M, et al. Does perioperative hemodynamic optimization protect renal function in surgical patients? A meta-analytic study. Database of Abstracts of Reviews of Effects (DARE): Quality-assessed Reviews, 2009.
26. Finkel KJ, Searleman AC, Tymkew H, et al. Prevalence of undiagnosed obstructive sleep apnea among adult surgical patients in an academic medical center. Sleep Med 2009;10(7):753-8.
27. Memtsoudis S, Liu SS, Ma Y, et al. Perioperative pulmonary outcomes in patients with sleep apnea after noncardiac surgery. Anesth Analg 2001;112(1):113-21.
28. Qaseem A, Snow V, Fitterman N, et al. Risk assessment for and strategies to reduce perioperative pulmonary complications for patients undergoing noncardiothoracic surgery: a guideline from the American College of Physicians. Ann Intern Med 2006; 144(8):575-80.
29. Smetana GW, Lawrence VA, Cornell JE. Preoperative pulmonary risk stratification for noncardiothoracic surgery: systematic review for the American College of Physicians. Ann Intern Med 2006;144(8):581-95.
30. Lawrence VA, Cornell JE, Smetana GW. Strategies to reduce postoperative pulmonary complications after noncardiothoracic surgery: systematic review for the American College of Physicians. Ann Intern Med 2006;144(8):596-608.
31. Nagappa M, Patra J, Wong J, et al. Association of STOP-Bang questionnaire as a screening tool for sleep apnea and postoperative complications: a systematic review and bayesian meta-analysis of prospective and retrospective cohort studies. Anesth Analg 2017;125(4):1301-8.
32. Diaz-Fuentes G, Hashmi HR, Venkatram S. Perioperative evaluation of patients with pulmonary conditions undergoing non-cardiothoracic surgery. Health Serv Insights 2016; 9(1):9-23.
33. Capozzi JD, Lepkowsky ER, Callari MM, et al. The prevalence of diabetes mellitus and routine hemoglobin A1c screening in elective total joint arthroplasty patients. J Anaesth 2017;32(1):304-8.
34. Singh JA, Lewallen DG. Diabetes: a risk factor for poor functional outcome after total knee arthroplasty. PLoS One 2013;8(11):e78991.
35. Marchant Jr MH, Viens NA, Cook C, et al. The impact of glycemic control and diabetes mellitus on perioperative outcomes after total joint arthroplasty. J Bone Joint Surg Am 2009;91(7):1621-9.
36. SS MA. A review of prevalence of obesity in Saudi Arabia. J Obes Eat Disord 2016; 2:1-6.
37. Blagojevic M, Jinks C, Jeffery A, et al. Risk factors for onset of osteoarthritis of the knee in older adults: a systematic review and meta-analysis. Osteoarthr Cartil 2018; 18(1):24-33.
38. Rodriguez-Merchan EC. Outcome of total knee arthroplasty in obese patients. Orthop. Surg 2015;23(1):107-10.
39. Groen VA, Van de Graaf VA, Scholtes VA, et al. Effects of bariatric surgery for knee complaints in (morbidly) obese adult patients: a systematic review. Obes Rev 2015; 16(2):61-70.
40. Dakka MA, Badri H, Al-Khaffaf H. Total knee arthroplasty in patients with peripheral vascular disease. Surgeon 2009;7(6):362-5.
41. Singh JA. Smoking and outcomes after knee and hip arthroplasty: a systematic review. J Rheumatol 2011;38(9): 1824-34.
42. Thomsen T, Villebro N, Møller AM. Interventions for preoperative smoking cessation. Cochrane Database Syst Rev 2014;3:CD002294.