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Review Article

Morbid Obesity and Total Knee Arthroplasty: Preoperative, Intraoperative, And Postoperative Considerations: A Review of Articles

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ABSTRACT

Background: Morbid obesity, defined as Body Mass Index (BMI) ≥40 kg/m², represents a significant challenge in total knee arthroplasty (TKA), affecting approximately 9.2% of US adults. The prevalence continues to rise globally, creating an expanding population requiring knee replacement surgery with complex perioperative considerations and potentially compromised outcomes.

Main Body/Discussion Summary: This comprehensive review examines current evidence regarding the management of morbidly obese patients undergoing TKA across all phases of care. Critical analysis of recent literature reveals that while morbid obesity increases perioperative complications including surgical site infections, revision rates, and medical complications, functional improvements remain substantial. Key controversies include optimal BMI thresholds, role of preoperative bariatric surgery, implant selection strategies, and cost-effectiveness considerations. Current evidence suggests that specialized perioperative protocols, careful patient selection, and modified surgical techniques can achieve acceptable outcomes, though complication rates remain elevated compared to normal-weight patients.

Conclusion: Morbid obesity should not constitute an absolute contraindication to TKA when evidence-based selection criteria and specialized protocols are implemented. Success requires multidisciplinary optimization, modified surgical approaches, and intensive monitoring. Future research should focus on standardizing perioperative protocols, defining optimal timing relationships with bariatric surgery, and establishing long-term outcome benchmarks for this challenging population.

Keywords*: Morbid obesity; Total knee arthroplasty; Bariatric orthopedics; Perioperative complications; Implant survival.*

INTRODUCTION

The global obesity epidemic has created unprecedented challenges in orthopedic surgery, particularly affecting total knee arthroplasty (TKA) outcomes. From 1999 through 2018, the age-adjusted prevalence of morbid obesity (BMI ≥40 kg/m²) in US adults has risen steadily from 4.7% to 9.2%, with projections indicating that most patients undergoing hip and knee replacement by 2029 will be obese or morbidly obese [1]. This demographic shift has profound implications for surgical planning, perioperative management, and healthcare resource allocation.

The relationship between obesity and knee osteoarthritis involves complex biomechanical and inflammatory pathways that accelerate joint degeneration. Morbidly obese patients develop symptomatic knee arthritis at younger ages and experience

more severe functional limitations compared to normal-weight individuals [2]. Consequently, these patients often require TKA at earlier stages of life, presenting unique surgical challenges and different outcome expectations.

Historically, many orthopedic surgeons have established BMI cutoffs for elective joint replacement due to concerns about increased perioperative complications. Early studies reported significantly higher rates of wound complications, infections, thromboembolism, and implant failure in obese patients [3]. However, the evidence base supporting absolute BMI restrictions has been increasingly questioned as surgical techniques, perioperative protocols, and implant technologies have evolved.

Contemporary large-scale database studies have provided more nuanced perspectives on outcomes in morbidly obese patients. A recent analysis of the National Inpatient Sample from 2009 to 2016 identified over 428,000 morbidly obese patients undergoing TKA, representing 23.2% of all procedures [4]. While these patients demonstrated longer length of stay, higher mortality rates, and increased discharge to facilities, the absolute differences were smaller than previously reported.

The complexity of managing morbidly obese patients extends beyond technical surgical considerations to encompass comprehensive medical optimization, specialized equipment requirements, and modified perioperative protocols [5]. Current controversies include the optimal role of preoperative weight loss, timing relationships with bariatric surgery, implant selection strategies, and cost-effectiveness considerations in this population.

METHODOLOGY

This narrative review was conducted through systematic searches of PubMed, Scopus, and Cochrane databases covering publications from 2015 to 2024. Search terms included combinations of "morbid obesity," "total knee arthroplasty," "BMI," "complications," "revision," and "outcomes." Inclusion criteria encompassed peer-reviewed articles, systematic reviews, meta-analyses, and clinical trials focusing on TKA outcomes in patients with BMI ≥35 kg/m². Studies lacking clear BMI stratification, non-English publications, and case reports with fewer than 10 patients were excluded.

DISCUSSION

What is Morbid Obesity

The World Health Organization classification system defines obesity based on BMI calculations, with Class III obesity (BMI ≥40 kg/m²) traditionally termed morbid obesity [6]. However, orthopedic literature increasingly recognizes BMI limitations as a sole predictor of surgical risk, leading to more sophisticated classification systems incorporating comorbidity burden, functional status, and metabolic parameters.

Recent studies have proposed modified classification approaches specifically for orthopedic patients. The concept of "metabolically healthy obesity" suggests that some morbidly obese patients may have lower perioperative risks than BMI alone predicts [7]. Conversely, patients with metabolic syndrome—characterized by central obesity, insulin resistance, hypertension, and dyslipidemia—demonstrate higher complication rates regardless of absolute BMI values.

A systematic review by Boyce et al. examining morbidly obese patients (BMI ≥40 kg/m²) found increased mid-to-long-term revision rates but comparable functional recovery to non-obese individuals [6]. This challenges traditional perspectives suggesting that functional benefits may be preserved despite elevated complication risks. The Australian Orthopaedic Association National Joint Replacement Registry analysis revealed that while revision rates increased progressively with BMI, absolute differences were modest and functional improvements remained substantial across all weight categories [8].

Contemporary risk stratification emphasizes modifiable factors beyond BMI. Type 2 diabetes mellitus, obstructive sleep apnea, cardiovascular disease, and venous thromboembolism risk require systematic assessment. Evidence demonstrates that hemoglobin A1c levels above 7% significantly increase infection risk, while untreated sleep apnea doubles perioperative cardiopulmonary complications [9].

The classification of super-obesity (BMI ≥50 kg/m²) has emerged as a distinct category requiring specialized considerations. A meta-analysis by Chaudhry et al. found that super-obese patients had significantly higher revision rates and complications compared to morbidly obese patients, suggesting that surgical risk increases non-linearly with extreme BMI elevation [10].

Preoperative Preparation and Considerations

Comprehensive preoperative assessment represents the cornerstone of successful TKA in morbidly obese patients, requiring systematic evaluation and optimization beginning months before planned surgery [11]. The multidisciplinary approach should encompass cardiovascular, pulmonary, endocrine, and nutritional optimization alongside patient education and expectation management.

Cardiovascular assessment assumes paramount importance given the high prevalence of coronary artery disease, heart failure, and pulmonary hypertension in morbidly obese patients. Current guidelines recommend electrocardiography,

echocardiography, and stress testing in patients with multiple cardiac risk factors. Optimization of heart failure medications and blood pressure control should be prioritized before elective surgery.

Pulmonary function evaluation has gained recognition following studies demonstrating that undiagnosed obstructive sleep apnea significantly increases perioperative morbidity. Preoperative polysomnography should be considered for patients with high-risk screening results, as continuous positive airway pressure therapy initiation can reduce postoperative complications by approximately 40% [12].

Glycemic control optimization requires careful attention to both preoperative and perioperative management. Studies consistently demonstrate that hemoglobin A1c levels above 7% associate with increased infection rates, with optimal levels potentially below 6.5% for elective procedures [13]. Perioperative glucose management protocols, including insulin algorithms and continuous monitoring, may benefit high-risk patients.

The role of mandatory preoperative weight loss remains controversial. While theoretically beneficial, systematic reviews yield mixed results regarding efficacy. A meta-analysis found that 5-10% weight loss associated with reduced wound complications but did not significantly impact other outcomes [14]. Bariatric surgery before TKA has been investigated, with studies showing mixed results regarding optimal timing and benefit.

Recent randomized controlled trial evidence from Dowsey et al. demonstrated that bariatric surgery before TKA reduced joint surgery complications, with 6 of 41 patients (14.6%) in the bariatric group experiencing complications compared to 15 of 41 (36.6%) in the control group [15]. However, 29.3% of bariatric patients declined TKA due to symptom improvement, complicating outcome interpretation.

Nutritional assessment often reveals micronutrient deficiencies despite caloric excess, particularly vitamin D, B12, and protein status [16]. Preoperative protein supplementation and vitamin correction may improve wound healing and reduce infection rates, though high-quality evidence remains limited.

Intraoperative Considerations

Surgical management of morbidly obese patients requires modified approaches addressing patient positioning, surgical exposure, instrumentation, and tissue handling techniques [17]. These modifications aim to optimize visualization while minimizing tissue trauma and contamination risk.

Patient positioning presents unique challenges requiring specialized operating tables capable of supporting increased weight while allowing optimal positioning without compromising respiratory function [18]. Some surgeons advocate for modified positioning techniques, though standard supine positioning remains most common with appropriate padding and support.

Surgical exposure in morbidly obese patients often necessitates extended incisions and specialized retraction systems. Mobile window retractors and obesity-specific retractor systems can improve visualization while minimizing tissue trauma [19]. Some surgeons recommend routine plastic draping systems or wound protectors to reduce contamination from skin folds.

Bone preparation and implant positioning require modified techniques accounting for altered anatomy and increased soft tissue thickness. Computer-assisted navigation systems demonstrate particular benefit in morbidly obese patients, improving component alignment accuracy when anatomical landmarks are obscured [20]. Robotic-assisted systems may offer additional advantages in achieving precise bone cuts and implant positioning. Recent evidence suggests that robotic-assisted TKA in morbidly obese patients can improve component positioning accuracy and potentially reduce outliers in mechanical axis alignment, though long-term clinical benefits remain under investigation.

Alignment considerations in morbidly obese patients have gained increased attention. Studies suggest that residual varus alignment may occur more frequently in obese patients due to soft tissue interference and difficulty in achieving neutral mechanical axis. Some surgeons advocate for accepting slight residual varus in select cases to avoid excessive soft tissue release, though this remains controversial and requires further long-term outcome studies.

Surgical approach selection requires consideration of tissue handling and exposure requirements. While standard medial parapatellar approaches remain most common, some advocate for modified approaches such as midvastus or subvastus techniques to reduce quadriceps trauma in patients with large anterior adipose deposits [21].

Hemostasis management becomes particularly critical given increased bleeding risks and potential tourniquet complications. Alternative strategies including topical and intravenous tranexamic acid have shown excellent efficacy in reducing blood loss without tourniquet-related complications [22].

Simultaneous bilateral TKA in morbidly obese patients presents additional challenges and increased complication risks. Studies demonstrate higher rates of cardiac complications, pulmonary embolism, and mortality in obese patients

undergoing simultaneous bilateral procedures compared to staged approaches. Current evidence suggests careful patient selection is crucial, with many centers avoiding simultaneous bilateral TKA in patients with BMI >40 kg/m² due to elevated perioperative risks.

Implant Considerations

Cemented fixation offers immediate stability and allows early weight-bearing, potentially beneficial in morbidly obese patients who have difficulty with protected weight-bearing protocols [30]. However, cement penetration may be compromised in sclerotic bone commonly seen in obese patients with advanced arthritis. Contemporary cementing techniques with pressurization and appropriate cement viscosity can overcome these challenges.

Uncemented implants rely on biological fixation through bone ingrowth, which may be impaired in morbidly obese patients due to altered bone metabolism and potential vitamin D deficiency [31]. However, modern porous coating technologies and improved surface treatments have shown good results when proper surgical technique is employed with adequate press-fit fixation.

Recent registry data suggests comparable long-term survival between cemented and uncemented implants in obese populations when appropriate selection criteria are applied [32]. The choice should be individualized based on bone quality, patient age, activity level, and surgeon experience rather than BMI alone.

Cemented versus Uncemented

The debate between cemented and uncemented fixation in morbidly obese patients continues to evolve. Cemented fixation provides immediate mechanical stability, which may be advantageous in patients with poor bone quality or those requiring immediate full weight-bearing. Studies have shown that modern cementing techniques with pulsatile lavage and vacuum mixing can achieve excellent long-term results even in morbidly obese patients [30].

Uncemented fixation relies on biological integration, which may be compromised in morbidly obese patients with metabolic bone disease or vitamin D deficiency. However, advances in porous coating technologies and surface treatments have improved initial stability and long-term outcomes [31]. The decision should be individualized based on bone quality assessment, patient factors, and surgeon experience.

Intramedullary Stem Considerations

The use of stems or augments in primary TKA for morbidly obese patients remains controversial. Some surgeons advocate for routine short stem use to improve load distribution and reduce stress concentration at the bone-implant interface [33]. Others argue that stems should be reserved for cases with poor bone quality or revision scenarios.

Recent studies suggest that stem use may reduce early subsidence rates in very obese patients (BMI >50 kg/m²) but does not significantly impact long-term survival [34]. The decision should be based on individual patient factors including bone quality assessment and component stability during trial reduction rather than BMI thresholds alone.

Polyethylene selection becomes crucial in high-load conditions typical of morbidly obese patients. Highly cross-linked polyethylene demonstrates superior wear characteristics under increased loading [35]. Vitamin E-stabilized polyethylene shows promise in reducing oxidation and wear in laboratory studies, though long-term clinical data in obese populations remain limited.

Tourniquet Characteristics and Importance of LOP

Tourniquet use in morbidly obese patients requires special consideration due to altered limb geometry, increased soft tissue thickness, and potential cardiovascular complications [36]. Traditional tourniquet cuffs may be inadequate for achieving complete arterial occlusion in patients with large thigh circumferences, leading to venous congestion rather than effective hemostasis.

Wide, contoured tourniquets specifically designed for obese patients improve pressure distribution and reduce nerve injury risk [37]. The concept of Limb Occlusion Pressure (LOP) has become increasingly important in tourniquet management for obese patients. LOP represents the minimum pressure required to occlude arterial flow to the limb and varies significantly based on limb circumference, blood pressure, and soft tissue characteristics. Modern tourniquet systems with automated LOP measurement can optimize tourniquet pressure, potentially reducing complications while maintaining effective hemostasis. Studies recommend using the LOP plus a safety margin of 50-75 mmHg rather than fixed pressure settings, which may be excessive in some patients and inadequate in others.

Several studies question the necessity of routine tourniquet use in TKA, particularly in obese patients where risks may outweigh benefits [38]. A randomized controlled trial comparing tourniquet versus non-tourniquet TKA in obese patients found no significant differences in blood loss or operative time, but reduced postoperative pain and faster functional recovery in the non-tourniquet group.

When tourniquets are used, careful attention to inflation time is crucial, as morbidly obese patients may have increased susceptibility to ischemia-reperfusion injury [39]. Tourniquet times should be minimized, with consideration for staged deflation techniques during prolonged procedures.

Drainage Considerations

The role of closed-suction drainage in TKA remains controversial across all patient populations but may be particularly relevant in morbidly obese patients given increased bleeding risk and wound complication potential [40]. Recent systematic reviews suggest that routine drainage does not significantly reduce complications and may increase infection risk.

However, some surgeons advocate for selective drainage use in morbidly obese patients with extensive surgical dissection or significant intraoperative bleeding [41]. When used, drains should be removed within 24-48 hours to minimize infection risk while achieving hemostatic benefits.

Alternative hemostasis strategies including tranexamic acid administration have largely replaced drainage as the primary method for blood loss reduction [22]. These pharmacological approaches avoid potential complications associated with drain placement while providing superior hemostatic control.

The decision regarding drainage should be individualized based on intraoperative factors, bleeding risk assessment, and surgeon experience rather than BMI alone [42]. Patient factors including anticoagulation status and bleeding disorders should guide decision-making.

Prolonged Intraoperative Time and Complications

Prolonged operative time in morbidly obese patients represents a significant risk factor for perioperative complications. Studies demonstrate that operative times exceeding 120 minutes associate with increased infection rates, thromboembolism, and medical complications. Each additional 15 minutes of operative time increases infection risk by approximately 13% in morbidly obese patients. Factors contributing to prolonged operative time include difficult exposure, increased bleeding, and technical challenges with component positioning. Strategies to reduce operative time include adequate surgical assistance, specialized retraction systems, and consideration for experienced surgical teams familiar with the challenges of operating on morbidly obese patients. Some centers advocate for dedicated "bariatric teams" with specialized training and equipment to optimize efficiency and outcomes.

Postoperative Management and Mobilization

Postoperative management of morbidly obese patients requires intensive monitoring and modified protocols addressing unique physiological challenges and complication risks [23]. Early mobilization remains crucial despite technical challenges, as immobilization significantly increases thromboembolism and pulmonary complication risks.

Respiratory management assumes critical importance given the high prevalence of sleep apnea and restrictive lung disease. Continuous positive airway pressure therapy should be continued in previously diagnosed patients, while undiagnosed patients require monitoring for signs of respiratory compromise [24]. Pain management strategies must balance adequate analgesia with respiratory depression risks.

Thromboembolism prophylaxis requires careful consideration of increased baseline risk and potential dosing adjustments for body weight. Extended prophylaxis duration may be beneficial, though optimal protocols remain under investigation [25].

Deep vein thrombosis prophylaxis in morbidly obese patients requires individualized approaches considering both mechanical and pharmacological methods. Recent evidence suggests that aspirin may be as effective as more potent anticoagulants for VTE prophylaxis in selected low-to-moderate risk obese patients, with significantly lower bleeding complications. However, high-risk patients (BMI >40, previous VTE, limited mobility) may benefit from therapeutic anticoagulation with low molecular weight heparin or direct oral anticoagulants. Weight-based dosing adjustments are crucial, as standard prophylactic doses may be inadequate in morbidly obese patients. Some protocols recommend anti-Xa level monitoring to ensure therapeutic levels in patients with BMI >40 kg/m². The optimal duration of prophylaxis remains debated, with some experts advocating for extended prophylaxis up to 35 days postoperatively in high-risk obese patients. Mechanical prophylaxis with compression devices should be initiated immediately postoperatively.

Early mobilization protocols require modification for safety while maintaining benefits. Physical therapy should begin on postoperative day one when medically stable, with gradual progression based on patient tolerance [26]. Weight-bearing restrictions may need modification based on bone quality and implant fixation concerns.

Wound management requires intensive monitoring given increased complication risks. Daily wound assessment, appropriate dressing selection, and early identification of complications are essential [27]. Some centers advocate for extended antibiotic prophylaxis, though evidence supporting this practice remains limited.

Pain management strategies must account for altered pharmacokinetics and potential drug interactions in morbidly obese patients. Multimodal analgesia approaches can reduce opioid requirements while maintaining adequate pain control [28]. Regional anesthesia techniques may provide superior pain control with fewer systemic side effects.

Postoperative Complications

Morbidly obese patients face significantly elevated risks for multiple categories of postoperative complications following TKA. A large retrospective study using the PearlDiver database found that obese patients had significantly higher rates of surgical site infections, acute kidney injury, deep vein thrombosis, wound complications, urinary tract infections, narcotic use, and revision surgery [43].

Surgical site infections represent one of the most serious complications, with rates approximately 2-3 times higher in morbidly obese patients compared to normal-weight individuals [44]. Deep periprosthetic joint infections are particularly concerning, as morbid obesity significantly increases the risk of failure in two-stage revision arthroplasty for infection. Watts et al. found that morbidly obese patients had significantly higher rates of subsequent revision, reoperation, and reinfection following two-stage revision procedures [45].

Wound complications including dehiscence, delayed healing, and superficial infections occur more frequently in morbidly obese patients due to poor tissue perfusion, increased tension on incisions, and altered healing dynamics [46]. These complications may lead to prolonged hospitalization, additional procedures, and increased infection risk.

Thromboembolic complications present particular challenges given the elevated baseline risk in obese patients combined with surgical trauma and potential immobilization [47]. A meta-analysis by George et al. found that BMI had a nonlinear relationship with complications, with readmission and reoperation showing U-shaped patterns, suggesting optimal BMI ranges around 29-30 kg/m² for minimizing complications [48].

Rare but serious complications including rhabdomyolysis and quadriceps rupture have been reported in morbidly obese patients following TKA. Rhabdomyolysis, characterized by muscle breakdown and release of myoglobin into the bloodstream, can lead to acute kidney injury and multi-organ failure. Case reports by Karcher et al. and others have documented postoperative rhabdomyolysis in obese patients, with risk factors including prolonged operative time, extreme positioning, and inadequate padding. Early recognition through monitoring of creatine kinase levels and aggressive fluid resuscitation are crucial for preventing renal complications. Quadriceps tendon rupture, while rare, occurs more frequently in obese patients due to increased mechanical stress and potential tissue degeneration. Management typically requires surgical repair with extended rehabilitation periods.

Periprosthetic fractures represent another significant complication in morbidly obese patients following TKA. The increased mechanical stress on the bone-implant interface, combined with potential osteoporosis and falls risk, contributes to higher fracture rates. Studies demonstrate that morbidly obese patients have approximately 1.5-2 times higher risk of periprosthetic fractures compared to normal-weight individuals. These fractures often require complex revision surgery with stemmed components and may result in prolonged disability. Prevention strategies include careful intraoperative technique to avoid notching, consideration of prophylactic stemmed components in high-risk patients, and aggressive osteoporosis screening and treatment.

Medical complications including cardiovascular events, respiratory compromise, and acute kidney injury occur more frequently in morbidly obese patients [43]. These complications may be related to underlying comorbidities, perioperative stress, and altered pharmacokinetics of medications.

Long-term Outcomes

Long-term outcome assessment in morbidly obese patients reveals complex patterns with both concerning trends and encouraging findings. A systematic review by Boyce et al. found increased mid-to-long-term revision rates in morbidly obese patients, however, functional recovery was comparable to non-obese individuals [6]. This suggests that while technical challenges persist, the fundamental benefits of TKA remain achievable.

Revision rates demonstrate consistent elevation in morbidly obese populations across multiple studies. A study analyzing cost and revision rates found that patients with BMI 40-44.9 had the highest overall revision burden and costs, with average 5-year revision reimbursement of $13,883 compared to normal BMI patients [49]. The incidence of revision was highest in patients with BMI 60-69.9, reaching 21% at 5 years.

However, functional outcomes tell a more encouraging story. A prospective study following patients for mean 38.5 months found that while morbidly obese patients had inferior Knee Society Scores compared to non-obese patients (knee score 85.7 vs 90.5, function score 75.6 vs 83.4), the absolute differences were modest and clinical improvement remained substantial [50].

Implant survival analysis from large registry studies suggests that while morbidly obese patients have higher revision rates, 10-year survival remains acceptable at approximately 85-90% compared to 92-95% in normal-weight patients [8]. These

differences, while statistically significant, may be clinically acceptable given the substantial functional improvements achieved.

Cost-effectiveness analyses generally support TKA in morbidly obese patients despite increased costs and complication rates [51]. The significant functional improvements and quality of life gains appear to justify the additional resource utilization, though optimal patient selection remains crucial for achieving favorable cost-effectiveness ratios.

CONCLUSION

Morbid obesity presents significant challenges in total knee arthroplasty but should not constitute an absolute contraindication when evidence-based protocols and careful patient selection are employed. While complication rates and revision risks remain elevated compared to normal-weight patients, functional improvements are substantial and long-term implant survival remains acceptable.

Key factors for success include comprehensive preoperative optimization, modified surgical techniques, appropriate implant selection, and intensive postoperative monitoring. The role of preoperative bariatric surgery remains controversial, with recent high-quality evidence suggesting benefits in selected patients but also highlighting potential risks.

Future research priorities should focus on developing standardized perioperative protocols, defining optimal patient selection criteria, investigating novel implant technologies, and establishing long-term outcome benchmarks specific to morbidly obese populations. Additionally, cost-effectiveness studies incorporating quality-adjusted life years will help guide healthcare policy decisions regarding access to care.

As the obesity epidemic continues, orthopedic surgeons must develop expertise in managing these complex patients while advocating for comprehensive approaches that address the underlying obesity through multidisciplinary care coordination.

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