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RESEARCH

Recommendations of an international Delphi study group for total knee arthroplasty in obese patients

Ashok Rajgopal[1] · Dhanasekara Raja Palanisami[2] · Adarsh Annapareddy[3] · Moin Khan[4] · Raju Easwaran[5] · Ashok Shyam[6] · Sahil Sanghavi[6] · Parag Sancheti[6]

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Abstract

Introduction Total knee arthroplasty (TKA) in obese patients poses multiple challenges and there is a lack of consensus on various aspects of TKA in this patient population. This study is a modified Delphi consensus study of international experts to provide recommendations on TKA in obese patients.

Materials and methods The consensus statements were generated using an anonymized two-round modified Delphi questionnaire, sent to an international panel of 53 knee surgeons, with an 80% agreement being set as the limit for consensus. The responses were analysed using descriptive statistics, with median as the measure of central tendency. Anonymized feedback was provided to all panellists based on responses from previous rounds to help generate the consensus.

Results 9 statements reached a consensus: WHO classification (87%), BMI cut-off for single-stage bilateral TKA (92%), use of tibial stem (84%), medial parapatellar approach (92%), same surgical approach as non-obese TKA (92%), inherent malnutrition (82%), higher risk of aseptic loosening in BMI class 3 (81%), need for time interval between bilateral TKA (88%), and consensus against leaving the knee in slight flexion (82%). The panel was unable to reach a consensus on 17 statements.

Conclusion This indicates lack of consensus on a majority of issues among experts and further research is required in this field to address evidence gaps, so we can improve our management of this increasing cohort of patients undergoing TKA. The statements reaching consensus form an important set of recommendation to improve patient selection and outcomes.

Level of evidence Level V

Keywords Knee arthroplasty · Obesity · WHO classification · BMI · Modified Delphi

✉ Sahil Sanghavi
sahil.sanghavi@hotmail.com

Ashok Rajgopal
a_rajgopal@hotmail.com

Dhanasekara Raja Palanisami
dhanasekararaja@gmail.com

Adarsh Annapareddy
dr.adarshannapareddy@gmail.com

Moin Khan
khanmm2@mcmaster.ca

Raju Easwaran
contact@drraju.in

Ashok Shyam
drashokshyam@gmail.com

Parag Sancheti
sanchetipk@yahoo.com

[1] Medanta The Medicity, Gurgaon, India

[2] Ganga Hospital, Coimbatore, India

[3] Sunshine Hospitals, Hyderabad, India

[4] McMaster University, Hamilton, Canada

[5] Max Super Speciality Hospital, Delhi, India

[6] Sancheti Institute For Orthopaedics & Rehabilitation, Pune, India

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Introduction

Obesity is a growing epidemic leading to a rise in the proportion of obese patients undergoing a total knee arthroplasty (TKA) [1]. With increasing healthcare costs for primary and revision TKA in developed countries like the United States [2], the rising costs are also expected to pose a major economic burden for developing nations [3]. Only a few clinical pathways are available to optimize the perioperative management for obese patients undergoing TKA, such as the New York Arthroplasty Council (NYAC) Consensus on Reducing Risk in Total Joint Arthroplasty [4]. The American Academy of Hip & Knee Surgeons (AAHKS) workgroup convened to review the evidence and reprised that the risk of complications following total joint arthroplasty (TJA) was increased dramatically in patients with a Body Mass Index (BMI) of 40 and above [5].

There has been a 4-fold increase in the number of obese patients undergoing knee arthroplasty [6]. In addition, there are conflicting reports in literature with regards to the risk of revision in obese patients undergoing TKA [7, 8]. This increase mandates a clinical care pathway and consensus on the management of this patient population, setting the background of this study [9, 10]. The objectives of this study were to develop a consensus on the definition, BMI cut-off, pre-operative patient optimization, intra-operative precautions including surgical techniques and prosthetic considerations, and post-operative management protocols to optimize outcomes for obese patients undergoing TKA.

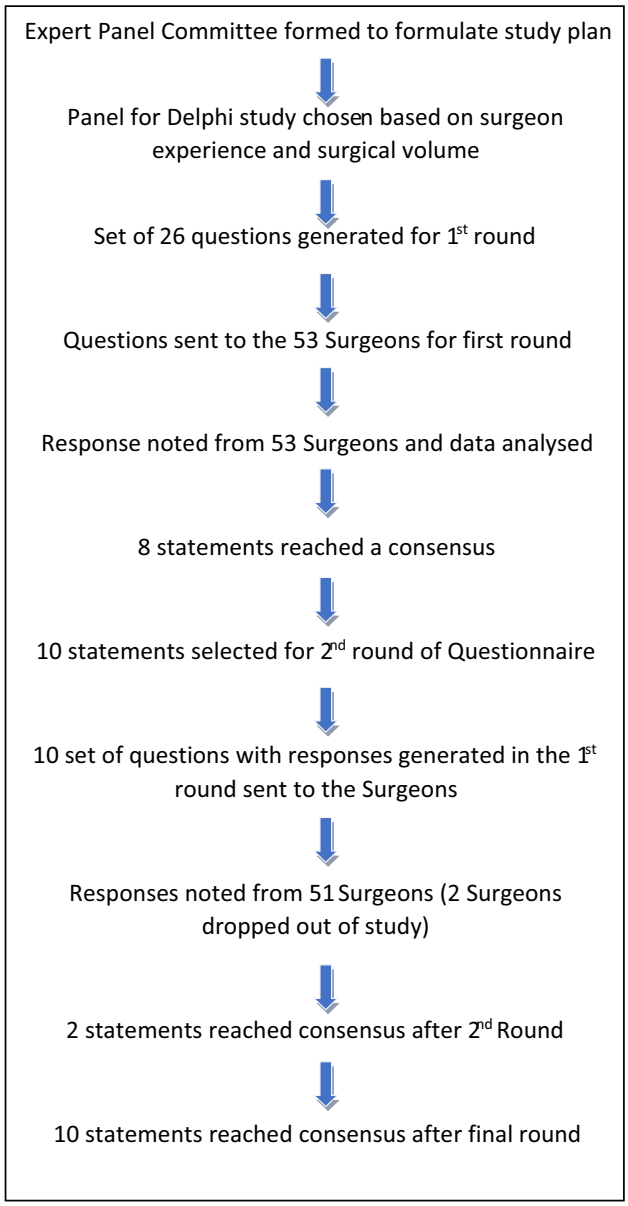

Fig. 1 Flow chart

Methods

Consensus participants

For selection of the panel, the authors reached out to orthopaedic surgeons across the globe to ensure a diverse panel with appropriate geographical variation. For a surgeon to fit the criteria to be a panel member, they had to be performing a minimum of 300 TKAs per year and have at least 15 years' experience. A panel of 53 international surgeons with extensive experience in the field of arthroplasty were selected to participate in this Delphi study. 2 participants were excluded because they did not respond to the second-round questionnaire despite repeated reminders. As Delphi methodology requires iterative participation from the same panel across all rounds, their non-response prevented inclusion in the subsequent analysis. Therefore, we proceeded with the study based on the responses of the remaining participants. (51/53) The research committee included six orthopaedic surgeons, one arthroplasty fellow and one PhD candidate.

Delphi method

The study was conducted over a period of six months, from July 2024 to January 2025. The Delphi method study comprised two rounds (Fig. 1). The committee framed 26 questions covering various aspects of obesity in TKA based on existing literature (Table 1). The survey questions were intentionally developed by the author group to cover the broad spectrum of clinical decision-making challenges encountered when performing TKA in obese patients. Each question was chosen based on its perceived relevance, contemporary controversies in the literature, and the collective clinical experience of the panel. As such, the

Table 1 Tabular format presentation of the survey questions and response options that were circulated to the panel members

Sr no.	Statement	Options
1)	The WHO classification of obesity can be used to stratify patients as obese while doing a TKA	Strongly agree Agree Neutral Disagree Strongly Disagree
2)	What according to you should be the BMI cut off for NOT offering a unilateral TKA	35 40 45 50 and above No contraindication
3)	What according to you should be the BMI cut off for NOT offering a single stage bilateral TKA (considering similar comorbidities).	35 40 45 50 and above No contraindication
4)	What according to you is the commonest cause of revision in the obese patients?	Infection Instability Loosening Malalignment
5)	Compared to nonobese patients, what is the class of obese patients who have higher incidence of revision due to loosening.	BMI Class 1 (30-35) BMI Class 2 (35-40) BMI Class 3 (>40)cut off No class preference for this complication
6)	What form of DVT prophylaxis do you prefer for the obese patient undergoing a TKA?	Low molecular weight heparin Aspirin with mechanical pumps Newer oral anticoagulants Other
7)	What according to you should be the interval duration between surgeries in obese patients if you do B/L TKA?	Single stage bilateral TKR Sequential bilateral TKR in same hospital admission (3-7 days) 1 month 3 months
8)	What is your preferred prosthesis of choice (Level of constraint) in an obese patient?	CR Rotating platform Congruent design PS Constraint
9)	What according to you should the BMI cut-off be to use a tibial stem in obese patients?	35 40 45 50 and above
10)	Tourniquet use in obese patients?	Larger cuff and higher tourniquet pressure. Larger cuff and pressure based on systolic pressure No tourniquet Tourniquet during cementing
11)	Would you change your surgical approach in obese patients undergoing TKA	Yes No
12)	What is your surgical approach for knee exposure in an obese patient undergoing TKA?	Standard medial parapatellar approach Subvastus MIS Medial parapatellar with quadriceps snip
13)	What is your preferred alignment target in obese patients?	Neutral mechanical alignment Kinematic alignment Personalized alignment Constitutional alignment Other
14)	How do you address the patella in obese patients?	Never resurface Always resurface Selective resurfacing Other

Table 1 (continued)

Sr no.	Statement	Options
15)	There is increased analgesic & opioid utilization requirement in obese patients	Strongly agree Agree Neutral Disagree Strongly disagree
16)	The PROMs at "1 year" after TKA in obese patients are same as in nonobese patients	Strongly agree Agree Neutral Disagree Strongly Disagree
17)	Obese patients can be malnourished	Strongly agree Agree Neutral Disagree Strongly Disagree
18)	Bariatric surgery in suitable obese patients with symptomatic osteoarthritis can avoid or postpone TKA	Strongly agree Agree Neutral Disagree Strongly Disagree
19)	Bariatric surgery should be considered for all morbidly obese patients before TKA	Yes No
20)	What according to you is the ideal interval between bariatric surgery and TKA?	At least 6 months. 6 months - 1 year >1 year
21)	There is increased incidence of knee instability in TKA after bariatric surgery due to generalized laxity of tissues.	Strongly agree Agree Neutral Disagree Strongly Disagree
22)	What do you feel about routine BMD assessment for obese patients and treatment of osteoporosis before doing a TKA?	BMD assessment is not part of preoperative work up. Treatment of osteoporosis is done preoperatively before the TKR. Osteoporosis management is done side by side Does not make any major difference.
23)	Leaving the knee in slight flexion at the end of the surgery is preferred in obese patients	Strongly agree Agree Neutral Disagree Strongly Disagree
24)	Using a thicker poly in obese patients and "avoiding the thinnest poly" leads to better longevity of the prosthesis:	Strongly agree Agree Neutral Disagree Strongly Disagree
25)	Use of drain in obese patient is beneficial	Strongly agree Agree Neutral Disagree Strongly Disagree
26)	Central obesity (metabolic syndrome) is not a big problem as long as patient has thin legs (no peripheral obesity) and I would still go ahead with the TKA	Strongly agree Agree Neutral Disagree Strongly Disagree

questionnaire was designed to capture the most important domains—preoperative selection, intraoperative technique, implant choice, alignment philosophy, and postoperative considerations.

These questions were circulated using Google Forms™. In round one, surgeons anonymously answered 26 questions using a 5-point Likert scale, with mandatory responses and an optional comment section. The Likert scale comprised of the following 5 points: strongly agree, agree, neutral, disagree, and strongly disagree. A consensus threshold of 80% was set based on previous literature [11]. For questions where a Likert scale was not applicable, various categorical quantitative and qualitative response options were provided for the panelists to choose from. Since categorical items do not measure graded agreement, Likert-based metrics (median, IQR) are not appropriate for determining consensus for these questions. Therefore, as per standard Delphi methodology for nominal data, consensus was defined as: ≥80% agreement on any single response option. This threshold was pre-specified and applied consistently across all categorical questions.

Results from round one were summarized and returned to the surgeons. In round two, tailored infographics were created based on individual responses. Panelists not in agreement were selected for consensus in subsequent rounds. Questions that did not reach the ≥80% consensus threshold in round one but showed a directional majority (more than 50% agreement for a single option) were recirculated in round two to non-cordant panelists. Questions that received a fragmented response, with no option exceeding 50%, were excluded from further rounds. Each panelist received controlled feedback including an infographic of the collective round-one responses, a box plot, anonymized panel comments, and a reminder of their own initial response. They were invited, but not obligated, to reconsider or maintain their original answer in light of this information. Round-two responses were then reassessed alongwith round-1% distributions to determine whether the combined agreement across both rounds met the predefined≥80% consensus threshold.

Statistical analysis

The characteristics of the respondents and the panelists' response rates are presented using descriptive statistics. For the sake of interpretation, categorical responses were transformed into numerical values to offer medians and measures of response spread. Microsoft Excel™ was used to compute medians and produce box plots for graphically visualizing the overall group response. Google Forms™ automatically generated the mode for all questions.

Results

The panel was made up of a diverse group of members. There were 24 members from Asia, 11 from USA, 11 from Europe & UK, and 7 from Australia. Of the 26 questions, 7 statements reached a consensus after round one and 2 statements reached consensus at the end of round two. The statements that reached consensus after both rounds and those not reaching consensus are presented in Tables 2 and 3 respectively.

Discussion

The main aim of this study was to generate consensus on important surgical aspects of obese patients undergoing TKA. To the best of our knowledge, this is first study of its kind. Consensus was reached for 9 out of 28 questions with many important insights into this clinical scenario. The discussion has been divided into two sections. Section 'A' discusses the statements reaching consensus and Section 'B' discusses the statements that did not reach a consensus. For ease of understanding and uniformity, each statement has been re-written at the beginning of the paragraph with the panel response as the first sentence, followed by relevant literature. While anonymity between panelists was preserved throughout the study, the research team had access to individual responses in order to provide controlled, personalised feedback for round two. This limited degree of investigator unblinding is inherent to Delphi methodology but remains a methodological limitation.

A) Statements reaching consensus

1. The WHO classification of obesity can be used to stratify patients as obese while doing a TKA.

Our panel endorsed the WHO's BMI classification despite geographical variation. One of the baseline parameters for obesity research is acceptance of a common definition. The WHO and NIH guidelines mention that WHO's BMI classification may underestimate the risk in Asian population [1], however, American Association of Hip and Knee Surgeons (AAHKS) including members of the Evidence-Based Medicine (EBM) recommend global applicability [2, 12]. The recommendation of our panel endorses this applicability, possibly due to ease of data collection and analysis for research.

Table 2 List of Questions / Statements which reached a consensus along with their distribution are shown. Statements no.3 and 10 reached a consensus after the 2nd round

Sr. No.	Question	Response categories					Consensus
a)	Questions with Likert scale:	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	
1.	The WHO classification of obesity can be used to stratify patients as obese while doing a TKA	25	62	11	2	-	87
17.	Obese patients can be malnourished	39	43	14	2	2	82
23.	Leaving the knee in slight flexion at the end of the surgery is preferred in obese patients (consensus against statement i.e. not preferred)	-	6	12	74	8	82
*b)	Questions with BMI cut-off	35	40	45	50 and above	No cut-off	
3.	What according to you should be the BMI cut off for not offering a single stage bilateral TKA	28	42	13	9	8	92
9.	What according to you should the BMI cut-off be to use a tibial stem in obese patients?	34	42	6	2	16	84
c) Other questions:							
7.	What according to you should be the interval duration between surgeries in obese patients if you do B/L TKR?	Single stage bilateral	Sequential (3-7 days apart)	1 month	3 months	-	88
		12	6	8	74		
11.	Would you change your surgical approach in obese patients undergoing TKR	Yes			No		92
		8			92		
12.	What is your surgical approach for knee exposure in an obese patient undergoing TKR?	Medial parapatellar	Sub-vastus	MIS	Medial parapatellar with quads snip		92
		92	4	2	2		
		34	47	19			
5.	Compared to nonobese patients, what is the class of obese patients who have higher incidence of revision due to loosening BMI Class 1 (30-35) BMI Class 2 (35-40) BMI Class 3 (>40) cut off No class preference for this complication	BMI class 1 (30-35)	BMI class 2 (35-40)	BMI class 3 (> 40)	No class preference		81
		-	5	81	14		

*For questions in section 'b' (BMI cut-off items), consensus was assessed by dichotomising the five response categories into: (1) 'any BMI cut-off' (combining 35, 40, 45, and ≥50) versus (2) 'no cut-off'

3. What according to you should be the BMI cut off for NOT offering a single stage bilateral TKA (considering similar comorbidities).
7. What according to you should be the interval duration between surgeries in obese patients if you do B/L TKA?

Our panel reached a consensus to avoid single-stage bilateral TKA in obese patients and that an interval should separate TKAs in these patients. However, there was no agreement on the specific duration of this interval. Many papers have suggested morbid obesity to be a contraindication for simultaneous bilateral TKA, citing increased morbidity and mortality [13–16]. However, Agarwala et al. found in their case-control study that single-stage bilateral TKA in obese patients yields similar outcomes to non-obese patients in terms of improved quality of life and post- operative function, with no difference in complications [17]. Chan et al. concluded that increased BMI does not increase post-operative complications, suggesting that obesity alone shouldn't deter single-stage bilateral TKA [18].

5. Compared to nonobese patients, what is the class of obese patients who have higher incidence of revision due to loosening?

In round one, our experts were divided on the class of obesity which would have a higher incidence of revision due to loosening. However, in round two, consensus emerged for class 3 (i.e. BMI > 40). Patients with morbid obesity (BMI > 40) undergoing TKA face increased early complications and re-operation rates compared to obese (BMI < 40) and non-obese patients (BMI < 30) [19]. In their retrospective study of 22,289 primary TKA patients, Wagner et al. reported that the revision rate for patients with BMI > 30 kg/m2 was 7.9% [20]. The risk notably escalates beyond a BMI of 45.0 kg/m² (4). These complications primarily involve

Table 3 List of questions / statements not reaching consensus after both rounds

Sr. No.	Statement
2.	What according to you should be the BMI cut off for not offering a unilateral TKA?
4.	What according to you is the commonest cause of revision in the obese ?
6.	What form of DVT prophylaxis do you prefer for the obese patient undergoing a TKA?
8.	What is your preferred prosthesis of choice (Level of constraint) in an obese patient?
10.	Torniquet use in obese patients
13.	What is your preferred alignment target in obese patients?
14.	How do you address the patella in obese patients?
15.	There is an increased analgesic and opioid requirement in obese patients
16.	The PROMs at "1 year" after TKA in obese patients are same as in non-obese patients
18.	Bariatric surgery in suitable obese patients with symptomatic osteoarthritis can avoid or post-pone TKA
19.	Bariatric surgery should be considered for all morbidly obese patients before TKA
20.	What according to you is the ideal interval between bariatric surgery and TKA?
21.	There is increased incidence of knee instability in TKA after bariatric surgery due to generalized laxity of tissues.
22.	What do you feel about routine BMD assessment for obese patients and treatment of osteoporosis before doing a TKA?
24.	Using a thicker poly in obese patients and "avoiding the thinnest poly" leads to better longevity of prosthesis
25.	Use of drain in obese patients is beneficial
26.	Central obesity (metabolic syndrome) is not a big problem as long as patient has thin legs (no peripheral obesity) and I would still go ahead with the TKA

aseptic loosening, skin necrosis, and surgical site infections [19, 21]. Friedman et al. found that the risk of aseptic loosening doubled for those with a BMI ≥ 35 kg/m² [22]. Other Studies too reported a 5- fold higher focal osteolysis rates in patients with a BMI > 40 kg/m² [22].

9. What according to you should the BMI cut-off be to use a tibial stem in obese patients?

Our panel achieved consensus on this issue, advocating for the use of tibial stems for morbidly obese patients, though exact BMI cutoff points could not be determined. Abdel et al. found that the risk of aseptic tibial loosening was 4.9% for obese patients and it almost doubled in patients with BMI > 35 kg/m2, regardless of age and post-operative alignment [23]. Si et al. reported tibial loosening rate of 6.7% [23]. Tibial stem is believed to add stability and reduce aseptic loosening in obese patients by reducing stress on the baseplate [24]. Though reduced revision rates have been reported, the exact incidence could not be evaluated because of short follow- up periods or the absence of a control group [25]. Recent studies have reported contradictory results showing no difference [26] or increased minor revision rates in BMI class three [27]. Osan et al. (2023) observed in their study that higher revision rates were observed in obese class 2 (BMI 35–39.99) patients in the stemmed group compared to the non-stemmed group [27].

11. Would you change your surgical approach in obese patients undergoing TKA
12. What is your surgical approach for knee exposure in an obese patient undergoing TKA?

The panel members prefer using the same approach for obese patients as they would for their standard primary TKA, and the majority advocate for the standard medial para-patellar approach for exposure in obese patients. This has been supported by a prospective study by Guler et al., in which the clinical and radiological outcomes in two groups of obese patients was compared: one group operated with medial parapatellar arthrotomy and the other with mid-vastus approach [28]. Similar outcomes in both the groups were noted.

17. Obese patients can be malnourished

Contrary to the perception that obese individuals are well-nourished, the panel reached a consensus that obesity does not guarantee adequate nutrition, as confirmed by publications in cardiology and nutrition journals [29, 30]. These obese, malnourished patients can face severe consequences, especially during procedures like TKA. The consensus recommends routine nutritional screening and monitoring as part of pre-surgical evaluation for obese patients planning TKA.

23. Leaving the knee in slight flexion at the end of the surgery is preferred in obese patients (consensus against statement i.e. not preferred).

On the issue of leaving the knee in some flexion following TKA resulting in a better range of motion [31], our panelists came to a consensus and disagreed with this statement, finding no benefit in doing so.

B) Statements not reaching a consensus

2. What according to you should be the BMI cut off for NOT offering a unilateral TKA

Our panel could not arrive at a consensus value for BMI beyond which TKA is contraindicated.

The BMI cutoff for TKA varies significantly among surgeons and regions. BMI exceeding 45 kg/m² is associated with increased postoperative complications in TKA (4). A study by Friedman et al. (5) examined morbid obesity (BMI > 40 kg/m²) and identified increased early postoperative complications, including erythema, edema, gastrointestinal issues, wound problems, and respiratory infections. A recent systematic review emphasizes that TKA should not be denied solely based on BMI, as it often leads to substantial functional and quality-of- life improvements (6). Another study involving 22,808 primary TJA cases assessed morbidly obese patients, revealing a modest increase in complications with rising BMI, particularly noticeable beyond BMI 50. While morbid obesity independently predicts complications, no specific BMI cutoff for contraindicating arthroplasty can be recommended as the benefits of TKA outweigh the risks (8). Driscoll et al. (2024) in their retrospective study observed that WHO Obesity class did not associate with the timing, rate or invasiveness of reintervention [32].

4. What according to you is the commonest cause of revision in the obese patients ? (Infection / Instability / Aseptic Loosening / Malalignment)

Our experts were divided on the commonest cause of revision in obese patients. Bigham et al. (2023) in their study observed that obese patients were at a higher risk of primary revision due to stiffness and fibrosis and repeat revision due to component malposition while morbidly obese patients were at higher risk of primary revision due to implant loosening and dislocation [7]. TKAs in morbidly obese patients pose a higher risk of aseptic loosening due to increased stress on the cement prosthesis interface, leading to decreased survivorship [33]. Obese patients should be well-informed about the risks of these complications and maintain a regular follow-up schedule for early detection.

6. What form of DVT prophylaxis do you prefer for the obese patient undergoing a TKA?

A consensus could not be reached on the optimal modality for DVT prophylaxis in obese patients undergoing TKA. The most common modality was low molecular weight heparin (37.7%) followed by aspirin with mechanical prophylaxis (34%) and newer anticoagulants (24.5%). As most of our experts were from Asia, where the rate of DVT is reported to be lower [34], the greater recommendation for DVT prophylaxis is probably an indication that experts believe obesity to be an independent and significant risk factor for DVT and subsequently pulmonary embolism (PE).

8. What is your preferred prosthesis of choice (Level of constraint) in an obese patient?

The panel could not reach consensus on the level of constraint, though nearly 50% felt that posterior stabilized designs do better. In their retrospective study, Can et al. concluded that the use of posterior stabilized implants in obese patients undergoing primary TKA can prevent secondary instability [35]. They observed that the main cause of instability in cruciate retaining implants was posterior cruciate ligament incompetence [35]. In their comparative retrospective review, Kremers at al. concluded that the use of posterior stabilized implants gives better outcomes in obese patients [36].

10. Tourniquet use in obese patients

The panel members did not reach a consensus on tourniquet use in obese patients. Past studies have suggested a higher blood loss in obese patients compared to non-obese patients, as the operative time is increased due to increased depth and length of the operative field and increased operating difficulty [37, 38]. A retrospective study conducted by Zhirui et al. concluded that there is no association between the use of a torniquet and reduction in blood loss and increased postoperative complications following TKA [39].

13. What is your preferred alignment target in obese patients?

The panel showed wide variability with respect to alignment, with a neutral mechanical alignment being the most preferred. Some surgeons also mentioned the use of robotics to achieve their desired alignment in obese patients. This is in accordance with reported literature where there is no agreement on the optimal alignment strategy based on BMI. It has been found, however, that there is a greater risk of missing your alignment targets as BMI increases [40]. Conversely, other articles have found no effect of specific coronal plane alignment preference in obese patients [41]. As such, further research is required in this area.

14. How do you address the patella in obese patients?

Our results reflected a general preference toward resurfacing (routine or selective), but a recommendation for systematic resurfacing could not be made.

Regarding patellar resurfacing in TKA, opinions in the literature vary, but there is limited research on different BMI groups [42]. Some publications suggest that higher BMI may increase the risk of osteolysis in knees with resurfaced

patella due to elevated pressures [43], but conclusive evidence is lacking.

15. There is an increased analgesic and opioid requirement in obese individuals

Our study found no consensus on whether there was an increase in analgesic or opioid requirement in the obese patients after TKA. Literature also shows varying findings on this topic with some researchers claiming all BMI groups have comparable pain and functional scores by 24 months [44] and others claiming that there is an incremental increase in opioid analgesic requirement in ascending BMI groups [45]. Pain is very subjective and depends on individual pain thresholds and may not depend on BMI [46].

16. The PROMs at "1 year" after TKR in obese patients are same as in non-obese patients

Although there was no consensus, most of our panelists believed that patient-reported outcome measures (PROMs) at 1-year post-op were not different between obese and non-obese groups. Other studies do report a significant improvement in PROMs in morbidly obese patients, however, this was much lower than non-obese patients [21, 23, 47]. This point should be part of patient counselling to avoid unrealistic expectations. Ashton et al. (2023) in their study reported that despite being more debilitated preoperatively, patients who had a BMI 35 experienced greater improvements in PROMs compared to patients who had lower BMI [48].

18. Bariatric surgery in suitable obese patients with symptomatic osteoarthritis can avoid or post-pone TKR
19. Bariatric surgery should be considered for all morbidly obese patients before TKR
20. What according to you is the ideal interval between bariatric surgery and TKA?
21. There is increased incidence of knee instability in TKR after bariatric surgery due to generalized laxity of tissues.

Our study included four questions related to BS and TKA, and there were variable responses from the panel with no consensus. The majority (70.6%) of our panelists believed that bariatric surgery (BS) in carefully selected obese patients might delay or even eliminate the need for TKA, although a consensus was not reached.

Studies generally show a correlation between weight loss (via BS or other means) and reduced knee pain, potentially reducing the necessity for TKA [49, 50]. Some reports suggest that BS before TKA in obese patients can lower post-op complications related to diabetes and malnutrition [51] and reduce ICU stays, ventilator requirements, and readmission rates [50, 52, 53]. However, other studies found either no difference between TKA with or without prior BS [54, 55] or negative effects such as increased blood transfusion risks, infections, and revisions with prior BS [55–57]. Performing TKA beyond six months after BS was suggested as the ideal timing by Jiabin et al. 55. Oliver et al. concluded that there wasn't a significant difference in complication rates between patients operated on within six months and those within six months to one year after BS [58]. Ryan et al. reported higher rates of instability and infection in patients who underwent TKA after bariatric surgery as compared to low and high BMI groups who underwent TKA without any prior bariatric surgery [57]. Rechenmacher et al. (2023) found that medically supervised preoperative weight loss predicted improvement in physical function 3 months after TKA [59]. They also observed in another study that Preoperative weight loss did not predict adverse outcomes for patients who had Obesity Class II or III. 6-month weight loss had greater odds of adverse outcomes than 1-year weight loss and most significantly predicted the occurrence of 1-year PJI. Daniel Hameed (2023) in their study observed that weight loss should be achieved at least nine months before TKA to decrease infection risks [60]. Michelle Dowsey et al. (2002) in their study observed that eight loss following bariatric surgery reduced the risk of complications of TKA in people with BMI greater than or equal to 35 [50].

22. What do you feel about routine BMD assessment for obese patients and treatment of osteoporosis before doing a TKA?

Our panel was divided on the need for routine assessment of bone mineral density and its treatment prior to doing a TKA in obese patients. Many studies have reported a high prevalence of osteopenia or osteoporosis in patients undergoing TKA, in addition to low screening and treatment rates [61, 62]. In obese patients undergoing TKA, osteoporosis has been associated with a higher rate of periprosthetic joint infection (PJI) and aseptic loosening [63]. Given this additional risk, it may be worthwhile to evaluate this high risk cohort for osteoporosis before undergoing a TKA.

24. Using a thicker poly in obese patients and "avoiding the thinnest poly" leads to better longevity of prosthesis

Our panelists did not come to a consensus on this hypothesis. Berend et al. reviewed 6,070 primary TKAs with a single implant design. They reported a 0.7% failure rate in knees with a bearing of 14 mm or less, whereas knees with a bearing of more than 14 mm had a failure rate of 2.3% [64]. On the other hand, Greco et al. found similar re-operation

rates and 10-year survivorship free of revision, between thin (14 mm or less) vs. thick (more than 14 mm) polyethylene bearings [65].

25. Use of drain in obese patient is beneficial

Our panelists came to an even distribution in numbers for and against the usage of drains in obese patients, thereby no consensus was reached. The use of closed suction drains in TKA has slowly been on the downtrend as many papers show that there may not be much of a difference in blood loss, hemoglobin drop, infections, DVT, and range of movements [66].

26. Central obesity (metabolic syndrome) is not a big problem as long as patient has thin legs (no peripheral obesity) and I would still go ahead with the TKA.

68% of our panelists agreed that, despite central obesity, if the patient had thin limbs, they would not hesitate to perform a TKA, but this number was not enough to attain a consensus.

While BMI is commonly used to stratify obesity, it fails to differentiate between central and peripheral obesity. Armstrong et al. found lower extremity anthropometric measurements (superior and inferior knee circumference, ankle circumference) to be a better indicator of surgical difficulty and longer tourniquet times than BMI alone [67].We nearly reached a consensus on this statement, with 68% of our panel agreeing that distinguishing between central vs. peripheral obesity is important for surgical risk stratification and may also help to identify potential surgical candidates who would otherwise be deemed at a higher risk.

Conclusion

The study questions specifically aimed at evidence gaps in clinically important aspects of obese patients undergoing TKA. Although consensus was reached on 9 questions, there was lack of consensus for most of the questions, specifically where an objective cut off agreement was needed. This helps identify potential areas with existing evidence gaps and identifies areas where future research is needed, so as to improve our management of this increasing cohort of patients with higher risk-factors.

Author contributions Conceptualisation: AR, DR, PSMethodology: MK, AS, REAnalysis: MK, ASWriting: AA, SSSupervision: PS, AR-All authors reviewed the manuscript.

Data availability No datasets were generated or analysed during the current study.

Declarations

Conflict of interests The authors declare no Conflict of interests.

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