The Egyptian Journal of Hospital Medicine (October 2022) Vol. 89, Page 4450- 4456

Clinical Results of Primary Total Knee Arthroplasty in Morbid Obese Patients

Mohamed Ibrahim Salama, Mohamed Mahmoud Abdelazim*,
Mohamed El Sadek Attia, Ahmed Hashem Amin
Orthopedic Surgery Department, Faculty of Medicine, Zagazig University, Egypt
***Corresponding author:** Mohamed M. Abdelazim, **Mobile:** (+20): 01023986760,
Email: mohamedmahmoudabdelazem@gmail.com

ABSTRACT

Background: Obesity is one of the most serious health threats facing today's society that considering key risk factors for osteoarthritis development. This increase in total knee arthroplasty (TKA) is due to its superior postoperative outcome.

Objective: This study aimed to reduce morbidity and improving outcomes of patients suffering from primary knee osteoarthritis by using TKA.

Patients and methods: This study included 12 obese patients with advanced knee osteoarthritis at conducted in Orthopedic Department, Zagazig University Hospitals. All patients had undergone TKA prosthesis that used in this study was the NexGen Legacy posterior- stabilized (LPS)-Fixed Bearing Knee Systems with or without stem. All patients were followed up post operatively for clinical evaluations.

Results: There are progressive improving of knee function, range of motion and whole patient lifestyle after TKA noticed obvious after 6 months from surgery as the score values show that mean post-operative KSKS score (45.42 ± 6.64) was higher than mean pre-operative KSKS score (73.17 ± 12.9), with change improvement 61.1% (p-value <0.001). The Also, mean post-operative KSFS score (51.5 ± 3.8) was higher than mean pre-operative KSFS score (73.17 ± 12.90), with change improvement 41.3% (p-value <0.001).

Conclusion: TKA in morbid obese patients, regardless their age and other comorbidities had many advantages as a very obvious pain improving. The functional improvement was very obvious with great impact on the whole lifestyle.

Keywords: Obesity, Total Knee Arthroplasty, KSFS score, KSKS score, Zagazig University.

INTRODUCTION

Obesity is emerging as rising epidemic and one of the greatest worldwide health risks to the modern-day population. In a previous report, the World Health Organization (WHO) stated that 500 million of the world's population was obese [(1)]. In USA and UK, obesity affects nearly a third of the population in both countries. In 2015, Egypt had ranked firstly among the 20 most populous countries, as it show the highest level of age-standardized adult obesity [(2)]. In order to categorization and grading of obesity, WHO had described it in three classes according to body mass index (BMI): class I (over weight) 30.0-34.9 kg/m^2, class II (obese) 35.0- 39.9 kg/m2, and class III (morbid obese) ≥40.0 kg/m^2 [(3)].

In addition to obesity being one of the major risk factors for osteoarthritis (OA) development, epidemiologic research have shown a correlation between increasing BMI and rising risk of numerous chronic illnesses [(4)]. Since the primary TKA rate is higher in obese patients than in individuals with normal BMI, the link between obesity and knee OA is clearly established in the literature [(5)].

According to statistical research, the number of obese patients who underwent TKA and had a BMI of 40 or more (morbid obesity) has continuously climbed [(6)]. This rise in TKA is attributable to its favorable postoperative results when compared to those of many other orthopedic procedures, which led to a significant and sustained reduction in knee pain and disability as well as an improvement in quality of life, especially in patients who were resistant to conservative treatment [(7)].

A popular theory is that patients with high BMI experience knee overload, which increases impact stress on the tibial component and increases component loosening while decreasing prosthesis short-term survival [(8)]. There are conflicting findings regarding the influence of obesity on post-operative complications following TKA [(9)], as some studies have shown higher revision rates and lower functional scores in obese patients. On the other hand, other studies have reported similar results regardless of BMI [(10)].

According to **Gaillard *et al.*** [(11)], obese patients have inferior clinical outcomes and a higher risk of surgical complications, but obesity has no effect on the mid-term survival of implants. A systemic review of 9 studies demonstrated good outcomes of TKA in situations of morbid obesity [(12)]. The substantial improvement in that review may be explained by the function of sedentary lifestyle in minimizing the increasing rate of prosthesis wear in morbidly obese patients [(13)].

The procedure is likely to offer them a significant improvement in functional outcome and quality of life, even though they should be encouraged to lose weight before having TKA. Despite the increased risk of failure and inferior functional outcome of TKA in morbid obese patients, they should not be refused for the procedure based on their BMI value alone [(14)]. Therefore, this study aimed to reduce morbidity and improving outcomes of patients suffering from primary knee OA by using TKA.

Received: 11/5/2022
Accepted: 18/7/2022

PATIENTS AND METHODS

One-arm clinical trial was conducted including 12 patients with advanced Tricompartmental knee OA, underwent primary TKA at Orthopedic Surgery Department, Zagazig University Hospital. These patients managed by implant NexGen Legacy Posterior stabilized (LPS)-Fixed Bearing.

Inclusion criteria: All selected patients are skeletally mature with primary Knee OA, morbid Obese patients (BMI > 40), and accepted to participate in the study.

Exclusion criteria: Skeletally immature patients, secondary knee OA (Traumatic, Rheumatoid or S.L.E) and patients not willing or not fit for surgery.

All selected patients met the following:

1. History taking including personal data; calculation of patients' BMI= kg/m2 as (kg) is a person's weight in kilograms and (m2) is their height in meter; onset of complain, duration of symptoms, medication and other treatment modalities had been used for treatment.

2. Physical examination including the patients was fully examined systemically for any other disease. Complete knee assessment incudes skin condition, range of motion (ROM) active and passive, **medial collateral** ligament (MCL) and lateral collateral ligament (LCL) integrity was done with special attention toward any flexion deformity, test for extensor mechanism and quadriceps muscle function and strength, complete neurovascular assessment for any possible neurological impairment or vascular insufficiency.

3. Score systems for evaluation: Several tools have been developed to measure outcomes, compare performance, and provide a platform for quality improvement in orthopedic surgery. The Knee Society Score (KSS) was our choice to evaluate our patients preoperative and 6 months post-operative. The system is subdivided into a knee score that rate only the knee joint itself where pain, flexion contracture, extension lag, range of flexion, alignment, and stability are assessed; and a functional score that rates the patient's ability to walk and climb stairs. The knee score and function score are graded where a score of 80-100 represents excellent outcome, 70-79 good, 60-69 fair and a score below 60 is graded as poor [(14)].

4. Radiographic evaluation: A precise pre-operative radiological evaluation is the corner stone for a proper preoperative management of knee OA. Radiological evaluation consisted mainly of plain radiographs. The aim of preoperative radiological evaluation was to detect the knee alignment whether normal, varus or valgus, detect associated abnormalities and site of osteophytes and evaluate bone stock of the femoral and tibial condyles.

Each patient underwent a knee series which included true anteroposterior standing view; lateral view; long leg standing film and axial view**.**

A- Pre-operative measure:

Consent obtained from all patients, including: proposed procedure, preoperative investigations, post-operative rehabilitation and average time, possible complications and expected improving. Routine preoperative laboratory tests were done. Blood sample for group matching and 2 units of PRBCs and Other Labs: TSH, HbA1c are done. Additional investigations as ECG, Echo were performed.

B- Intra operative management:

All patients were operated in supine position with stopper fixed to table on the knee while it is at least 90° flexed. Broad spectrum antibiotic (Ceftriaxone 1:2gm according body weight) was given just before induction of anesthesia. All operations were done under Spinal anesthesia. High above knee tourniquet was used in all cases. The implants used in this study were the NexGen Legacy posterior- stabilized (LPS)-FB Knee Systems. The femoral component of this implant show special geometries features with two convex spherical condyles with symmetric anatomic radii (medial and lateral condyles) in the sagittal plane and a larger distal radius and a smaller posterior radius, and includes a cam-spine mechanism. The component has a deep patellar groove that has been extended more distally and proximally than the traditional PS-TKA component. This allows the patella to be supported fully at as much as 85° of flexion. The tibial component: possesses a flat metallic surface shaped to lock the polyethylene liner.

- **Surgical Technique:**

Medial parapatellar approach was used for all patients. After skin incision begins in the medial quadriceps tendon above the superior pole of the patella till patella and quadriceps tendon then patella is flipped to lateral side of knee. Using the 8mm IM Drill to drill a hole in the center of the patellar sulcus of the distal femur. Suction the canal to remove medullary contents. The 3°Distal Placement Guide can be used to place the Mini Distal Femoral Cutting Guide in 3° of flexion to protect the anterior cortex from notching. While holding the Mini A/P Sizing Guide in place, secure the guide to the resected distal femur using short 3.2mm Headed Screws or predrill and insert short head Holding Pins into one or both of the holes in the lower portion of the guide. Use the Screw Inserter/Extractor to insert a 3.2mm Headed Screw on the beveled medial side of the guide. Then secure the lateral side in the same manner. Resection Guide (angle wing) used through the anterior cutting slot of the finishing guide. Use t narrow, reciprocating saw blade to cut the base of the trochlear recess.

For tibial preparation, place the spring arms of the Ankle Clamp around the ankle proximal to the malleoli. Each tip of the tibial depth resection stylus indicates a different depth. The hole that corresponds to the defective tibial condyle was used. The stylus will snap into the hole. We removed Telescoping Rod and the entire assembly, leaving the Cut Guide in place on the bone. With the knee in extension after insertion of the thinnest appropriate Spacer/Alignment Guide between the resected surfaces of the femur and tibia was done. A trial reduction is performed to check component position, patellar tracking, ROM, and joint stability. Use the correct size tibial plate provisional to ensure proper fit before implanting the final components. Inserter applies both downward and rearward forces to aid in the insertion of the articular surface onto the tibial base plate. The patella is finished by removal of whole osteophytes and excess bones then denervation by diathermy passes around the patella edges. A suction drain was used in all cases and was removed after 48 hours. Wound closure in layers with using skin stapler for skin closure in flexion.

C- Postoperative measures:

Bulky dressing was done in all cases that changed 1st day postoperative. Broad spectrum antibiotic for a week, oral analgesic, anti-edematous drugs, Anticoagulant (LMW heparin) were given to all patients. Post-operative Hemoglobin level was requested at the second day following the surgery and packed red cells were given if hemoglobin level was <8 gm/dl. All patients were educated well about the steps and importance of rehabilitation program; also they were informed about the schedule of follow up visits.

In this study wound condition was followed during the first 2 weeks and then staples were removed at 15 days of surgery. One patient developed superficial surgical wound infection managed by serial dressing with oral and intravenous antibiotics for two weeks. The response to treatment was good and resolution of the signs of infection occurred within 10 days.

Post-operative rehabilitation protocol consisted of three phases:

Immediate Post-Surgical Phase (I) (Day 0-3) including active/active assisted/passive (A/AA/PROM) exercises (seated and supine). Isometric quadriceps, hamstring, and gluteal isometric exercises. Straight leg raises (SLR). Lower extremity range of motion and strengthening. Gait training on flat surfaces as tolerated by the patient.

Motion Phase (II) (Day 3–Week 6) including active Assisted/Active/Passive ROM, stretching for flexion (>90degrees) and full extension. Continue isometric quadriceps, hamstring, and gluteal isometric exercises. Supine heel slides and seated Long Arc Quad (LAQ). Straight Leg Raising (SLR). Gait training to improve function and quality of involved limb performance during swing through and stance phase.

Phase III (weeks 6-12): Continue exercises listed in Phase II with progression including resistance and repetitions.

D- Follow up:

Schedule of follow up visits at outpatient clinics including a week post-operative to assess the wound healing and exclude any early post-operative skin complication. At 14th day post-operative staples were removed; 4weeks post-operative to follow up improvement and progression of physiotherapy. Patient assessed every month to assess progression in rehabilitation protocol. Full radiological and clinical evaluations of each patient were done.

Clinical evaluation:

All patients had been assessed according to Knee Society Scoring (KSS) which is divided into two sections: The Knee Score (100 points): Evaluates pain with 50 points (none, mild, moderate, severe), 25 points for range of motion, and 25 points for stability, dedications (minus) for flexion contracture, extension lag and malalignment. Knee Function score (100 points): divided in two sections that measure the ability to walk and the ability to go up and down stairs and deductions.

Radiological evaluation:

All patients had been assessed by plain x-ray films of knee with two views anteroposterior and lateral to detect any aseptic loosening, periprosthetic fractures, patella-femoral sublaxation.

Ethical consent:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis:

Data collected and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for Social Sciences (SPSS version 20.0) software for analysis. Qualitative data were represented as frequencies and relative percentages. Quantitative data were expressed as mean and standard deviation (SD). Paired t-test was used to compare between two dependent variables. P-value was set at $\leq$0.05 for significant results and $\leq$0.001 for high significant results.

RESULTS

The study was conducted on a variant age patient with no specific range, the mean age was 66.3 (SD 5.2). There was female predominance with female to male ratio 3:1. Seven (58.3%) patients were housewives, 4 (33.3%) patients were employers with office works, and 1 (8.3%) patient was a service worker. There were 8 (66.6%) patients underwent TKA of left side and 4 (33.3%) patients of right side. Also, 1 (8.3%) patient was smoker, and 1 (8.3%) patient was with history of allergy to medications **(Table 1)**.

Table (1): Demographic data of studied cases:

Demographic Data	No.	%
Age	**Mean (66.3 ± 5.2)**	
Sex:		
Male	**3**	**25%**
Female	**9**	**75%**
Occupation:		
Office	**4**	**33.3%**
Housemate	**7**	**58.3%**
Service workers	**1**	**8.3%**
Allergy to medications	**1**	**8.3%**
Smoker	**1**	**8.3%**
Site:		
Right	**4**	**33.3%**
Left	**8**	**66.6%**

The mean weight was 112.3 (SD 10.2), the mean height was 165.3 (SD 5.2), and the mean BMI was 42.5 (SD 3.2).

Table 2 summarizes co-morbidities of the participants.

Table (2): Associated comorbidities of studied cases:

Variable	Number	%
Cardiovascular Diseases:		
Hypertension	**8**	**66.6%**
Ischemic heart disease	**7**	**58.3%**
Endocrinal diseases:		
Diabetes militias	**8**	**66.6%**
Hypothyroidism	**3**	**25%**
Chest disease:		
Bronchial asthma	**2**	**16.6%**

The mean Hb was 11.7 (SD 1.4), the mean PCV was 35.5 (SD 4.4), mean creatinine was 1.1 (SD 0.2), the mean PT- INR 0.95 (SD 0.142), the mean Fasting (mmol/L) was 6.8 (SD 1.2), the mean postprandial Glucose Levels (mmol/L) was 10.5 (SD 1.6).

Table 3 summarizes preoperative and postoperative KSKS scores.

Table (3): Comparison between Pre and Post according to KSKS.

KSKS	Range	Mean ± SD	Paired Sample t-test			
			MD ± SE	Change %	t-test	P-value
Pre	**35-55**	**45.42 ± 6.64**	**27.75 ± 3.28**	**61.1%**	**-8.460**	**0.001***
Post	**55-91**	**73.17 ± 12.9**				

**Highly statistically significant differences (p<0.001). MD: Mean Difference; SE: Standard Error

Table 4 summarizes preoperative and postoperative KSFS scores.

Table (4): Comparison between Pre and Post according to KSFS.

KSFS	Range	Mean ± SD	Paired Sample t-test			
			MD ± SE	Change%	t-test	P-value
Pre	**44-57**	**51.50 ± 3.80**	**21.25 ± 1.24**	**41.3 %**	**-17.083**	**<0.001****
Post	**62-79**	**72.75 ± 5.15**				

**Highly statistical significant differences (p<0.001). MD: Mean Difference; SE: Standard Error

DISCUSSION

The management of knee OA and its debilitating symptoms has advanced significantly in recent decades to include TKA as a viable surgical option for severe OA. These advancements necessitate the evaluation of outcomes after TKA. Evaluation of functional limitations is particularly important because the number of obese patients receiving TKA is increasing [(15)]. Many challenges emerge during TKA in this group of population in all surgery steps started from selection of the candidate as unfitting for elective surgery has intimate relationship with morbid obesity [(11)].

In our study, we aimed to assess improvement of morbidly obese patients' lifestyle after TKA regardless their age group or other comorbidities or even type of there obesity and we prefer using the most distributed and subjective score; knee society scoring system for assessment of clinical and functional outcomes 6 months post operatively.

This study had no specific age group as primary OA emerging as one of geriatric degenerative diseases so the mean age of the patients included was 66.3 (SD 5.2). There was female predominance with female to male ratio 3:1. There were 3 male patients, while female patients were 9. The fact of association between obesity and chronic disease either the obesity was cause or result, that was clearly reflected in this study, as whole patients had had one or more comorbidity there were 8 patients with hypertension, 8 patients diagnosed with

DM, 7 patients with ischemic heart disease, 3 patients with hypothyroidism (Postthyroidectomy) and one patient with bronchial asthma.

Several studies in the literature evaluating the results of TKR in the obese patient, few have described the results in the morbidly obese [16].

In a single surgeon series, results of 50 primary TKRs performed in morbidly obese patients were compared with 1768 similar procedures carried out on patients who were not morbidly obese. At 5 years, the clinical outcome scores were significantly inferior in the morbidly obese group: there was a high rate of revision and of perioperative complications; 22% had wound complications and 10% deep infection [17]**.** These poor results in the morbidly obese patient, together with an increasing prevalence of obesity throughout Europe and North America, highlight the need for further evaluation of the results of TKR in this group of high-risk patients [18]**.**

This study showed that the mean age of participants was 66.3 (SD 5.2); there were 3 males and 9 females. **Amin *et al.*** [19], over 1700 TKRs were performed in their unit by many surgeons. Independent, prospective follow-up for all patients was undertaken by a dedicated audit team, led by an arthroplasty nurse practitioner and a physiotherapist who were not directly involved in the study and were not aware of the aims at the time of data collection. Their study showed that the mean age was 62.2, and there were 27% male and 73% female. Also, **Foran *et al.*** [20] showed that the mean age was 66 (SD 8.6), and there were 16 males and 62 females.

In a study by **Naziri *et al.*** [21], 101 knees in 95 patients (21 men, 74 women) who had a minimum BMI of 50 kg/m2 and who had undergone a primary TKA at 1 of the 4 high-volume institutions were compared with a group of patients who had a BMI less than 30 kg/m2 who were matched by age, gender, preoperative clinical scores, and mean follow-up. End points evaluated by chart review included implant survivorship, medical and surgical complications, functional parameters (The Knee Society Outcome Scores and ROM), and intraoperative variables at a mean follow-up of 62 months (range 36-85 months). The mean age was 60 years old; male to female ratio was 21:74.

Giesinger *et al.* [22] showed that Data were obtained for primary TKAs performed at a single centre over a 12-month period. Data were collected pre-operatively and 12-month postoperatively with the Oxford Knee Score measuring pain and function, the EQ-5D-3L measuring general health status, the Forgotten Joint Score-12 (FJS-12) measuring joint awareness and a single question on treatment satisfaction. The 402 participants had a mean age of 70.7 (SD 9.2) years and 55.2% were females.

The present study reported that the mean weight was 112.3 (SD 10.2), the mean height was 165.3 (SD 5.2), the mean BMI was 42.5 (SD 3.2). **Amin *et al.*** [19] showed that the mean weight was 111kg and BMI was 43.2.

In the study of **Foran *et al.*** [20] clinical and radiographic data on 78 TKAs in 68 obese patients were compared with data on a matched group of non-obese patients. The analysis was also performed after stratification of the obese group for the degree of obesity. All patients had the same prosthesis. The clinical data that were analyzed included the Knee Society objective and functional scores, patellofemoral symptoms, activity level, and complications. They showed that the mean BMI was 35.3 (SD 4.2).

Giesinger *et al.* [22] most patients were classified as being overweight (33.1%; BMI 25-29.9) or having class I obesity (28.1%; BMI 30-34.9). Twenty-eight patients (7.0%) had class III obesity (BMI $\geq$ 40.0). The influence of BMI on the eventual outcome following TKR remains uncertain. Several studies have compared the results in obese and non-obese patients, with follow-up ranging from 1 to 15 years [23].

The current study illustrated that the mean pain score was 7.2 (SD 0.56), the mean knee score preoperative was 28.4 (SD 3.2), the mean function score was 50.6 (SD 5.5). Similar to our results, **Amin *et al.*** [19] showed that the mean knee score preoperative was 28.2, the mean function score was 50.6.

Naziri *et al.* [21] showed that the mean preoperative Knee Society Objective Score was 53, and preoperative Knee Society Function Score was 52. The mean preoperative range of Flexion Arc was 84.

Mishra *et al.* [24] showed that a transition to a higher class of obesity was associated with poorer outcomes. Pain score gradually decreased with time in all the classes of obesity, with maximum decrease in a normal and overweight and minimum decrease in class III obesity. KSS and FKSS gradually improved with time in all classes, with morbidly obese patients having a minor improvement. The PROMs were better in all classes of obesity, as compared to the preoperative condition and class III obesity had the least satisfactory PROMs.

Increased body-weight results in increased loading across a TKR and the surrounding bone. This does not appear to produce high rates of failure in obese patients who have total knee replacements, probably because of the lower activity levels in these patients compared with non-obese patients. It is possible however, that in the patients who are morbidly obese, lower activity levels may not compensate for the higher stresses across the tibial component. This may explain the high rate of radiolucent lines and aseptic loosening observed in morbidly obese patients in the study [25].

This study showed that the mean Hb was 11.7 (SD 1.4), and the mean PCV was 35.5 (SD 4.4). **Prasad *et al.*** [26] showed that included a total of 66 consecutive patients who underwent primary TKA by a single surgeon. The mean Hb was 11.90 (SD 1.50), the mean PCV was 35.9 (SD 4.68).

In **Liu *et al.* [27]** study, preoperative coagulation functions did not differ significantly between patients with and without postoperative hematoma. Therefore, we are unable to predict the occurrence of hematoma based on preoperative coagulation functions. However, among patients with a hematoma, APTT was significantly prolonged to beyond 10 s on postoperative day 1 in comparison with baseline data. On the contrary, APTT in the non-hematoma group on postoperative day 1 was not significantly different from the baseline value. These results suggest that a prolonged APTT on postoperative day 1 may be predictive of hematoma formation. In addition, blood tests were performed on postoperative day 1 before the administration of apixaban. Therefore, the prolonged APTT was not caused by apixaban. Similar patterns were also observed for PT, which was significantly prolonged during the postoperative period in the hematoma group but not in the non-hematoma group.

This study demonstrated that that mean knee score was 85.5 (SD 8.2), and the mean function score was 75.4 (SD 7.1 SD). There were 5 with early post-operative wound healing, 3 with infection, 2 with DVT, 1 with pulmonary embolism. **Naziri *et al.* [21]** showed that the mean postoperative Knee Society objective score was 91, postoperative Knee Society function score 82. In **Amin *et al.* [19]** study, while the post-operative function score component of the KSS was significantly inferior in the morbidly obese group, the difference in the post-operative knee score component was not. This suggests that while morbidly obese patients may achieve similar pain relief, range of movement and stability, they are likely to remain more functionally impaired following TKR, with limitation of walking distance, ability to climb stairs and greater dependence on walking aids.

Amin *et al.* [19] also showed that the rate of peri-operative complications, where reported, has been found to be similar for obese and non-obese patients, although infection may be significantly higher for patients with a BMI >35 kg/m.

This study has certain limitations. A joint-specific outcome scoring system was used in the study, but use of a more patient-based outcome score may have provided more information regarding the clinical outcome. With the current rapid rise in average body-weight and prevalence of obesity, it is likely that clinicians will encounter an increasing number of patients who are morbidly obese requiring TKR. It is therefore imperative that we define the results of TKR in these patients early, and identify any pitfalls in the criteria for selection for an operation which has otherwise proved to be extremely successful in alleviating pain and improving mobility for a large number of patients.

In conclusion, TKA in morbid obese patients, regardless their age and other comorbidities had many advantages as a very obvious pain improving. The functional improvement was very obvious with great impact on the whole life style.

Conflict of interest: The authors declare no conflict of interest.
Sources of funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
Author contribution: Authors contributed equally in the study.

REFERENCES

1. **World Health Organization (2000):** Obesity: preventing and managing the global epidemic (No. 894). World Health Organization. https://apps.who.int/iris/handle/10665/42330
2. **GBD 2015 Obesity Collaborators (2017):** Health effects of overweight and obesity in 195 countries over 25 years. New England Journal of Medicine, 377(1):13-27.
3. **World Health Organization (2017):** Obesity. Available at: https://www.who.int/health-topics/obesity#tab=tab_1
4. **Jiang L, Tian W, Wang Y *et al.* (2012):** Body mass index and susceptibility to knee osteoarthritis: a systematic review and meta-analysis. Joint Bone Spine, 79(3):291-297.
5. **Flugsrud G, Nordsletten L, Espehaug B *et al.* (2006):** The impact of body mass index on later total hip arthroplasty for primary osteoarthritis: a cohort study in 1.2 million persons. Arthritis and Rheumatism, 54(3):802-807.
6. **Fehring T, Odum S, Griffin W *et al.* (2007):** The obesity epidemic: its effect on total joint arthroplasty. The Journal of Arthroplasty, 22(6):71-76.
7. **Kurtz S, Lau E, Ong K *et al.* (2009):** Future young patient demand for primary and revision joint replacement: national projections from 2010 to 2030. Clinical Orthopaedics and Related Research, 467(10):2606-2612.
8. **Gunst S, Fessy M (2015):** The effect of obesity on mechanical failure after total knee arthroplasty. Ann Transl Med., 3(20):310-314.
9. **Mulhall K, Ghomrawi H, Mihalko W *et al.* (2007):** Adverse effects of increased body mass index and weight on survivorship of total knee arthroplasty and subsequent outcomes of revision TKA. J Knee Surg., 20(3):199-204.
10. **Collins R, Walmsley P, Amin A *et al.* (2012):** Does obesity influence clinical outcome at nine years following total knee replacement? The Journal of Bone and Joint Surgery, 94(10):1351-1355.
11. **Gaillard R, Gaillard T, Denjean S *et al.* (2017):** No influence of obesity on survival of cementless, posterior-stabilised, rotatingplatform implants. Arch Orthop Trauma Surg., 137(12):1743-1750.
12. **Boyce L, Prasad A, Barrett M *et al.* (2019):** The outcomes of total knee arthroplasty in morbidly obese patients: a systematic review of the literature. Archives of Orthopaedic and Trauma Surgery, 139(4):553-560.

13. **McClung C, Zahiri C, Higa J *et al.* (2000):** Relationship between body mass index and activity in hip or knee arthroplasty patients. J Orthop Res., 18(19):35-39.
14. **Boyce L, Prasad A, Barrett M *et al.* (2019):** The outcomes of total knee arthroplasty in morbidly obese patients: a systematic review of the literature. Archives of Orthopaedic and Trauma Surgery, 139(4):553-560.
15. **Muckenhirn K, Chahla J, LaPrade R (2017):** Anatomy and biomechanics of the native knee and its relevance for total knee replacement. In: Soft tissue balancing in total knee arthroplasty. Springer, Berlin, Heidelberg, pp. 3-15.
16. **Sabharwal S, Root M (2012):** Impact of obesity on orthopaedics. JBJS., 94(11):1045-1052.
17. **Epstein N (2017):** More risks and complications for elective spine surgery in morbidly obese patients. Surgical Neurology International, 8:1-10.
18. **Price A, Alvand A, Troelsen A *et al.* (2018):** Knee replacement. The Lancet, 392(10158):1672-1682.
19. **Amin A, Patton J, Cook R *et al.* (2006):** Does obesity influence the clinical outcome at five years following total knee replacement for osteoarthritis? The Journal of Bone and Joint Surgery, 88(3):335-340.
20. **Foran J, Mont M, Rajadhyaksha A (2004):** Total knee arthroplasty in obese patients: a comparison with a matched control group. J Arthroplasty, 19:817-824.
21. **Naziri Q, Issa K, Malkani A *et al.* (2013):** Bariatric orthopaedics: total knee arthroplasty in super-obese patients (BMI> 50 kg/m2). Survivorship and complications. Clinical Orthopaedics and Related Research, 471(11):3523-3530.
22. **Giesinger J, Loth F, MacDonald D *et al.* (2018):** Patient-reported outcome metrics following total knee arthroplasty are influenced differently by patients' body mass index. Knee Surgery, Sports Traumatology, Arthroscopy, 26(11):3257-3264.
23. **Boyce L, Prasad A, Barrett M *et al.* (2019):** The outcomes of total knee arthroplasty in morbidly obese patients: a systematic review of the literature. Archives of Orthopaedic and Trauma Surgery, 139(4):553-560.
24. **Mishra A, Vaish A, Vaishya R (2022):** Effect of Body Mass Index on the outcomes of primary Total Knee Arthroplasty up to one year–A prospective study. Journal of Clinical Orthopaedics and Trauma, 27:101829.
25. **Chen L, Zheng J, Li G *et al.* (2020):** Pathogenesis and clinical management of obesity-related knee osteoarthritis: impact of mechanical loading. Journal of Orthopaedic Translation, 24:66-75.
26. **Prasad N, Padmanabhan V, Mullaji A (2007):** Blood loss in total knee arthroplasty: an analysis of risk factors. International Orthopaedics, 31(1):39-44.
27. **Liu C, Kakis A, Nichols A *et al.* (2014):** Targeted use of vancomycin as perioperative prophylaxis reduces periprosthetic joint infection in revision TKA. Clinical Orthopaedics and Related Research, 472(1):227-231.