Does Body Mass Index affect the outcomes of patients undergoing unicompartmental knee arthroplasty? A retrospective cohort study

Zhao Xuequan (zhao_han434589@sina.com)
Cangzhou Clinical College of Integrated Traditional Chinese and Western Medicine of Hebei Medical University

Dezhi Li
Neijiang hospital of Traditional Chinese Medicine

Zhao Bin
Cangzhou Clinical College of Integrated Traditional Chinese and Western Medicine of Hebei Medical University

Yao Shuzhang
Cangzhou Clinical College of Integrated Traditional Chinese and Western Medicine of Hebei Medical University

Liu Qinglei
Cangzhou Clinical College of Integrated Traditional Chinese and Western Medicine of Hebei Medical University

Research Article

Keywords: Unicompartmental knee arthroplasty, body mass index, function, pain

Posted Date: October 14th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-2141152/v1

Abstract

Background: Unicompartmental knee arthroplasty UKA has become one of the main methods for the treatment of unicompartmental knee osteoarthritis. There is still lack of medium term data on the outcomes of UKA and survival rate of prosthesis in different body mass index (BMI) groups.

Objective: we focus on the effectof BMI on the medium clinical outcomes of UKA.

Methods: The retrospective study included patients who received UKA at our hospital, between January 1, 2014 to December 31, 2017.All patients All patients underwent surgery of unicompartmental knee arthroplasty. They were divided into three groups according to BMI. normal body mass group [group A, BMI 14.50 24.99 kg/m2, 14 cases (16 knees)], overweight group [group B, BMI 25.00-27.99 kg/m2, 15 cases (17 knees)], obesity group[group C, BMI 28.00-39.99 kg/m2, 16 cases (18 knees)]. There was no significant difference in gender, age, sides, diseaseduration, and preoperative American Special Surgery Hospital (HSS) score, pain visual analogue scale (VAS) score, and knee range of motion (ROM) among 3 groups (P>0.05). The operation time, intraoperative dominant blood loss, and the postoperative decreased amount of hemoglobin at 2 week were recorded and compared among 3 groups. The the Knee Society Score (KSS), the University of California at Los Angeles (UCLA) activity scale Knee society score VAS score, and ROM were evaluated in three groups.

Results: Forty-five of 58 eligible patients were included. All the 45 patients were followed up 36-70 months, with an average of 57.55 months. The function of knee joint in all patients was improved and the pain was obviously relieved. Significant differences were found in the knee score, function score and the knee society score between three groups at 70-month follow-up (p<0.05).

Conclusions: For normal and overweight patients with anterior medial compartmental osteoarthritis of the knee joint, the use of minimally invasive UKA can achieve satisfactory short- and medium-term effectiveness. However, this procedure should be chosen carefully with overweight patients.

Introduction

Obesity is a main risk factor for the knee osteoarthritis (OA), and the rise of global obesity level will lead the greater demand for knee arthroplasty [1-2]. However, morbid obesity is considered a relative contraindication for knee arthroplasty because of the low survival rate of the prosthesis. unicompartmental knee arthroplasty (UKA) and total knee arthroplasty (TKA) are the main treatments for end-stage osteoarthritis.

a more appropriate patient selection has led to renewed interest and a boom of UKA in the last years. Results improved and survival rates of more than 90% after 15 years and 84% after 20 years have been reported [3–6].The main reason for different outcomes of UKA is discrepancy in ability surgical indications. There has been no consistent conclusion on the influence of BMI on the survival rate of the

prosthesis, and a large number of recent literatures reported that body weight and BMI of patients seemed to be unrelated to the overall revision rate of TKA [4-7].

Obesity is a global epidemic and it is estimated that more than 693 million people worldwide have signs of obesity [3]. Obesity increases the mechanical load on the knee joint, and a strong association between obesity and knee osteoarthritis has been reported in the literature [4]. The risk of knee osteoarthritis is almost four times higher in obese men than in non-obese men and five times higher in obese women [6]. Early onset of unicompartmental osteoarthritis is more common in obese patients [4]. In addition to TKA and high tibial osteotomy (HTO), UKA is a common procedure for unicompartmental osteoarthritis The UKA is a common surgical procedure for the treatment of unicompartmental osteoarthritis. Some studies have shown that UKA is more effective than HTO and TKA in the treatment of unicompartmental osteoarthritis of the knee [5-7]. However, there is still no consensus on whether obesity is a contraindication to UKA [8]. In recent years, the prevalence of obesity in the country has been on the rise [7]. The exact mechanism of how obesity, as an independent risk factor, affects the course of OA development is unclear. Studies [8] have shown that along with increased BMI, mechanical and chemical factors combine to promote damage to the subchondral bone and synovial membrane of weight-bearing joints, sensitize peripheral neurons, and cause focal loss of articular cartilage, ultimately leading to bone fragmentation and intra-articular deformity. Obesity is usually combined with severe endocrine and metabolic dysfunction and high mortality. Also, the risk of failure is significantly higher in obese patients undergoing artificial knee replacement.

The preoperative BMI of patients undergoing UKA keeps to an ambiguous variable and little has been studied concerning the clinical outcome parameters rather than survivorship. The present study was, therefore, conducted to investigate the potential association of the BMI of patients and the media clinical outcome 5 years after UKA[8-9].

Materials And Methods

After approval by the local ethical committee,We retrospectively reviewed the medical records of 45patients 51 knees who underwent UKA at our department from January 1, 2014 to December 31, 2017. Patients were included in the analysis if they met the following criteria: (1) identified preoperative diagnosis of osteoarthritis and only the anterior medial compartment was involved (2) magnetic resonance imaging MRI showed complete anterior cruciate ligament and collateral ligament, and the tenderness point was limited to the medial joint space. performed preoperation assessment manually by the orthopedist, such as the varus deformity Angle ≤10°, range of motion(ROM)≥90°, the angle of flexion contracture deformity <10°;(3)The lateral compartment and patellofemoral joint are intact (4) had follow-up of more than 3 years. Patients who underwent UKA for other diseases of the knee joint were excluded. The characteristics of the patients are listed in table 1.

According to World Health Organization (WHO) guidelines, the Patients in the study were divided into three groups, one was named Group A(BMI 14.50 24.99 kg/m2)including 14 patients (16 knees), and

other was named Group B(BMI 25.00 27.99 kg/m2) including 15 patients (17 knees), the other was named Group C(BMI 28.00 39.99 kg/m2 including 16 patients (18 knees). Preoperative examinations hematology and imaging tests were should be completed and surgical contraindications were ruled out.

The study was approved by the local Clinical Research Ethics Committees (NO.2019011), and written informed consent was waived due to the retrospective nature of the study.

Surgical procedure

The third-generation oxford knee prosthesis was selected for all intraoperative implants. All operations were completed by the same senior surgeon. The procedure was performed according the standard of oxford phase 3 unicompartmental knee arthroplasty.

Postoperative rehabilitation

After the surgery, all patients were required to perform ankle joint exercises, and the scope of motion was encouraged within tolerable range.One day after the surgery, isometric quadriceps, active ankle, and straight-leg raise exercises were commenced. practicing walking with the aid of a walker on the first day after surgery.Toe-touch weightbearing was initiated immediately after the surgery.At 1 weeks, the walking aid was removed.

Clinical and radiographic examination

Routine postoperative follow-up visits were scheduled at 1months, 3 months, 1 year, and yearly thereafter. Five years after surgery, clinical data were collected comprising the Knee Society Score (KSS) with knee and function subscores,the University of California at Los Angeles (UCLA)activity scale, and a visual analogue scale (VAS) to assess the presence and intensity of anterior knee pain.The ROM was determined using a goniometer; we assessed maximum knee flexion (°) and determined the presence of extension deficiencies (°).Implant failure was defined as conversion to total knee arthroplasty.

Statistical Analysis

The student test or the Fisher exact test was used to analyze continuous variables. Multiple comparisons were performed with repeated-measures analysis of variance (ANOVA). All computations were performed with standard software (SPSS version 22.0 for Windows; IBM), with significance set at $P< 0.05$.

Results

Descriptives

The mean BMI of the entire cohort was 25.98 ± 4.12 (range 15.57–34.38). The BMI did not differ significantly between women and men(P>0.05). Of all patients, 17.65% were classifid as normal weight, 74.51% as overweight, and 7.84% as obese, respectively.

Clinical outcome

We enrolled 58 patients in the trial. 1 patients died after 2-year of follow-up, outpatient follow-up failed in 9 cases, and 3 case was amputated due to lower limb tumor. Finally, a total of 45 patients met the study criteria and were included in the analysis. There were no significant differences in operation time, intraoperative dominant blood loss and the amount of hemoglobin lost at 1 week after operation among the three groups (P>0.05). All 45 patients were followed up 36-70 months (mean, 57.55 months). There were no complications such as infection, fat embolism and deep vein thrombosis. The anterior and lateral radiographs of the knee joint showed no dislocation or loosening of the prosthesis, and the prosthesis was in good position(Fig.3).

BMI and VAS were not correlated (r = 0.07, P = 0.60)(Fig.1). BMI and postoperative knee flexion were not correlated (r = 0.26, P = 0.06) (Fig.2). At last follow-up, the knee score, function score and the knee society score of the three groups were significantly significant (P<0.05).

Comparing the BMI of patients with poor or good outcomes we found no significant differences for all clinical variables as presented in Table 2, Two UKA failed and were converted to total knee arthroplasty, resulting in a failure rate of 3.9%. One knee failed due to loosening of the femoral component.The differences of UCLA activity level between the three groups were not statistically significant.

Discussion

It is reported in the literature [16-18] that compared with non obese patients, obese patients are more likely to suffer from OA disease when they are young. Patients who are overweight are at greater risk of developing OA disease. After the BMI index exceeds 27 kg/m2, the risk of OA increases by 15% for every increase in BMI index [19]. The possible reason is that with the increase of weight, the inversion angle of the lower limb force line in the weight bearing position increases [20], resulting in an increase in joint load and uneven force in the joint, which is bound to increase the damage of articular cartilage. Therefore, how to determine the appropriate joint replacement surgery program is the initial intention of this study.

This study evaluated whether BMI affected the medium and long-term clinical efficacy of Oxford platform single condylar replacement in the treatment of medial knee osteoarthritis. During follow-up, Knee score, Function score and Knee society score were significantly improved compared with those before operation, which was basically consistent with the improvement trend of overall imaging. This study also shows that the unilateral condylar replacement has a clear clinical effect in the treatment of unilateral knee osteoarthritis.

Xu et al[11]. found in a 10-year follow-up survey that the KSFS score and Oxford Knee Score (OKS) score of patients with BMI ≥ 30 were significantly reduced 10 years after surgery. However, a systematic evaluation of 80798 subjects showed that obesity did not lead to adverse outcomes after UKA, so it should not be considered as a contraindication to UKA. Another study reported that the average OKS score of the patient was 34 in 6 months after surgery, which was unrelated to the BMI of the patient. Woo

et al. found in the follow-up that obesity had no effect on the clinical results 2 years after UKA. This may indicate that the influence of obesity on the clinical results after UKA will not be shown in the short-term follow-up. In a 7-year follow-up study, Cavaignac et al. found that there was no correlation between obesity and KSFS and KSKS scores. The reason for the large difference in the research results may be related to the inconsistency of the BMI classification criteria used by different studies for different populations. This study adopts the WHO Asian standard, which is applicable to the reference of Chinese population. However, the severe obesity in China is equivalent to the obesity standard in Europe and the United States, and there may be some differences in the research results. It should be noted that the Asian standard for morbid obesity is BMI>40 kg/m2, which is usually associated with severe endocrine and metabolic dysfunction, so the mortality rate is high. Therefore, the risk of failure of knee arthroplasty for morbidly obese patients is significantly increased.

The results of this study showed that there were statistically significant differences among the three groups in the follow-up of Knee score, Function score and Knee society score. It shows that when BMI is greater than 28, the medium and long-term clinical efficacy of condylar replacement will be affected. It also shows that excessive weight or high BMI will shorten the service life of the knee prosthesis [21], which is due to increased wear of the prosthesis components. The negative effects of obesity in UKA patients also include delayed healing due to excessive incision tension, higher infection rate and reduced activity level in later rehabilitation training. This is basically consistent with the research results of Polar AE[12].

This study is a single-center retrospective study with inherent deficiencies of selection bias. First, the effect of BMI on prosthesis survival after UKA was not included in the study, which is a weakness of the study. Second, the small sample size is also a shortcoming of this study. The inclusion of a larger sample size for a longer follow-up may lead to more reliable results, which is the next goal of the researchers[22].

There have been many reports on this subject before[17-19], but most of them indicate that obese patients may benefit from UKA. In the present study, the KSS scores and HSS scores of patients in each group after surgery have been greatly increased, indicating that the quality of life of patients receiving UKA has improved; It further indicates that BMI ≥ 28kg/m2 will affect the improvement of knee joint function after operation. Therefore, we support that obesity is a relative contraindication for patients to receive UKA [10]. We believe that it is necessary to provide weight loss counseling and guidance for patients with severe obesity in order to improve the postoperative knee score, reduce the risk of postoperative complications and improve the quality of life.

Declarations

Ethical approval

Not applicable

Authors contributions

Zhao Xuequan and Li Dezhi participated in designing the study. Yao Shuzhang collected the data and did the field work. Zhao Bin and Liu Qinglei participated in writing the manuscript and revising it before submission. All authors read and approved the final manuscript.

Competing interests

Not applicable

Funding

Not applicable

Availability of data and materials

Not applicable

References

1. Ratnasingham S. The effect of body mass index on the change in disability and pain in hip and knee osteoarthritis. Master's thesis. Toronto: University of Toronto. 2003.
2. Ferguson J, Pandit H, Price A, et al. The impact of body mass index on the outcome of the unicompartmental knee arthroplasty. Orthop Proc. 2012;94-B(Supp_IX):34.
3. Sundaram K, Warren J, Anis H, et al. An increased body mass index was not associated with higher rates of 30-day postoperative complications after unicompartmental knee arthroplasty. Knee. 2019;26(3):720–8.
4. Xia Z, Liow MHL, Goh GS-H, Chong HC, Lo NN, Yeo SJ. Body mass index changes after unicompartmental knee arthroplasty do not adversely influence patient outcomes. Knee Surg Sports Traumatol Arthrosc. 2018;26(6):1691–7.
5. Watanabe T, Kreuzer S, Christopher JA, et al. Is there a difference in uni- and multi-compartmental knee arthroplasty kinematics? 2014.
6. Hu J, Xiong R, Chen X, Chen Z, Jin Z. Effect of components mal-alignment on biomechanics in fixed unicompartmental knee arthroplasty using multi-body dynamics model during a walking cycle. Med Eng Phys. 2022;100:103747.
7. Kreuzer SW, Banks S, Watanabe T, Pourmoghaddam A. Robotic modular tricompartmental knee arthroplasty: A case study. Orthop Proc. 2013;95(Supp_34):107.
8. Martin JR, Jennings JM, Dennis DA. Morbid obesity and total knee arthroplasty: a growing problem. JAAOS. 2017;25(3):188–94.
9. Zeng XW, Yang CX. Research progress of prosthesis survivorship for unicompartmental knee arthroplasty. Chin J Jt Surg Electron Ed. 2019;13(5):606–10.
10. Law GW, Abd Razak HRB, Goh GS-H, et al. Diabetes mellitus does not negatively impact outcomes and satisfaction following unicompartmental knee arthroplasty in well-controlled disease. Asia Pac J

Sports Med Arthrosc Rehabil Technol. 2019;16:24–9.
11. Xu S, Lim WJ, Chen JY, et al. The influence of obesity on clinical outcomes of fixed-bearing unicompartmental knee arthroplasty: a ten-year follow-up study. Bone Joint J. 2019;101-b(2):213 – 20.
12. Polat AE, Polat B, Gürpınar T, Çarkçı E, Güler O. The effect of morbid obesity (BMI ≥ 35 kg/m2) on functional outcome and complication rate following unicompartmental knee arthroplasty: a case-control study. J Orthop Surg Res. 2019;14(1):266.
13. Wilson HA, Middleton R, Abram SGF, et al. Patient relevant outcomes of unicompartmental versus total knee replacement: systematic review and meta-analysis. BMJ. 2019;364:l352.
14. Molloy J, Kennedy J, Jenkins C, Mellon S, Dodd C, Murray D. Obesity should not be considered a contraindication to medial Oxford UKA: long-term patient-reported outcomes and implant survival in 1000 knees. Knee Surg Sports Traumatol Arthrosc. 2019;27(7):2259–65.
15. Nettrour JF, Ellis RT, Hansen BJ, Keeney JA. High failure rates for unicompartmental knee arthroplasty in morbidly obese patients: a two-year minimum follow-up study. J Arthroplasty. 2020;35(4):989–96.
16. Zuo W, Ma J, Guo W, Zhang Q, Wang W, Liu Z. Comparison of the clinical outcomes of revision of failed UKAs to TKAs with primary TKAs: A systematic review and meta-analysis. Medicine (Baltimore). 2018;97(50):e13408.
17. Woo YL, Chen YQJ, Lai MC, et al. Does obesity influence early outcome of fixed-bearing unicompartmental knee arthroplasty? J Orthop Surg (Hong Kong).2017;25(1):2309499016684297.
18. Khow YZ, Goh GS, Chen JY, Lo NN, Yeo SJ, Liow MHL. Change in body mass index after simultaneous bilateral total knee arthroplasty: Risk factors and its influence on functional outcomes. J Arthroplasty. 2021;36(6):1974–9.
19. Abdulla I, Mahdavi S, Khong H, et al. Does body mass index affect the rate of adverse outcomes in total hip and knee arthroplasty? A retrospective review of a total joint replacement database. Can J Surg. 2020;63(2):E142-E9.
20. Burn E, Sanchez -Santos MT, Pandit HG. Ten-year patient -reported outcomes following total and minimally invasive unicompartmental knee arthroplasty: a propensity score-matched cohort analysis. Knee Surg Sports Traumatol Arthrosc. 2018;26(5):1455–64.
21. Greco NJ, Marfo KA, Berend KR. The mobile bearing in unicompartmental knee arthroplasty. In: Unicompartmental knee arthroplasty: Indications, surgical techniques and complications. In: Gerlinger T, editor. Cham: Springer; 2020; pp. 69–94.
22. Koppens D, Rytter S, Munk S, et al. Equal tibial component fixation of a mobile-bearing and fixed-bearing medial unicompartmental knee arthroplasty: a randomized controlled RSA study with 2-year follow-up. Acta Orthop. 2019;90(6):575–81.

Tables

Table.1 Patients Characteristics

Number	Gender F female M male	Height (kg)	Weight (cm)	BMI	Course of disease (year)	Affected side	Follow-up time
1	F	159	65	25.71	1.5	Right	70
2	F	160	55	21.48	2.5	Left	65
3	F	170	45	15.57	2	Right	64
4	F	165	50	18.37	3.5	Left	60
4A	F	165	50	18.37	3.5	Right	60
5	F	158	45	18.03	2	Left	62
6	F	160	70	27.34	3	Left	60
7	F	160	88	34.38	6	Right	62
8	F	158	75	30.04	6	Right	60
9	F	158	60	24.03	2	Right	63
10	F	156	65	26.71	7	Left	55
10A	F	156	65	26.71	7	Right	55
11	F	160	70	27.34	10	Right	58
12	M	160	74	28.91	5	Right	60
13	M	160	77.5	30.27	1	Right	57
14	M	160	65	25.39	1	Left	52
15	M	165	70	25.71	6	Left	55
16	F	167	55	19.72	2	Left	61
17	F	156	55	22.60	3	Right	62
18	F	158	75	30.04	5	Left	58
18A	F	158	75	30.04	5	Right	58
19	M	160	65	25.39	1.2	Right	58
20	M	182	90	27.17	2	Left	60
21	M	168	65	23.03	5.5	Right	36
22	M	175	66	21.55	4	Right	60
23	F	160	85	33.20	5	Right	60
24	M	175	60	19.59	5	Left	50

24A	M	175	60	19.59	5	Right	50
25	F	175	80	26.12	3	Right	55
26	F	168	85	30.12	20	Right	50
27	F	175	80	26.12	3	Right	52
28	F	155	65	27.06	1	Right	50
29	F	155	60	24.97	1	Left	53
30	M	156	75	30.82	4	Left	60
31	M	160	75	29.30	5	Right	57
31A	M	160	65	25.39	5	Right	52
32	F	160	75	29.30	5	Right	55
33	M	160	75	29.30	4.5	Left	61
34	M	160	65	25.39	5	Right	60
35	M	175	75	24.49	5	Right	57
36	F	165	65	23.88	1.2	Left	52
37	F	175	90	29.39	2	Left	55
38	M	168	65	23.03	5.5	Left	61
39	M	167	70	25.10	4	Left	62
40	M	156	65	26.71	3.5	Right	58
40A	F	158	70	28.04	2.5	Left	61
41	F	158	70	28.04	1.5	Left	62
42	F	160	65	25.39	2	Right	58
43	M	165	80	29.38	3	Left	58
44	M	155	70	29.14	3.5	Left	60
45	M	158	80	32.05	1.5	Left	55

Table 2 Comparison of postoperative clinical data between three groups

	Mean±SD			*F*/*P*
	Group A	Group B	Group C	
Postoperative Knee Flexion	125.31±9.57	127.19±2.37	124.38±10.78	0.52/0.6
Knee score	90.13±3.67	81.25±8.96	77.94±7.85	14.64/0.00
Function score	78.43±5.56	80.56±5.27	65.00±6.95	38.11/0.00
Knee society score	158.19±6.50	152.44±11.01	134.38±4.03	46.04/0.00
Extension deficiency	0 of 16	1 of 17	3 of 18	-
UCLA activity level	5.25±1.39	4.81±1.17	3.69±1.99	3.15/0.05

Figures

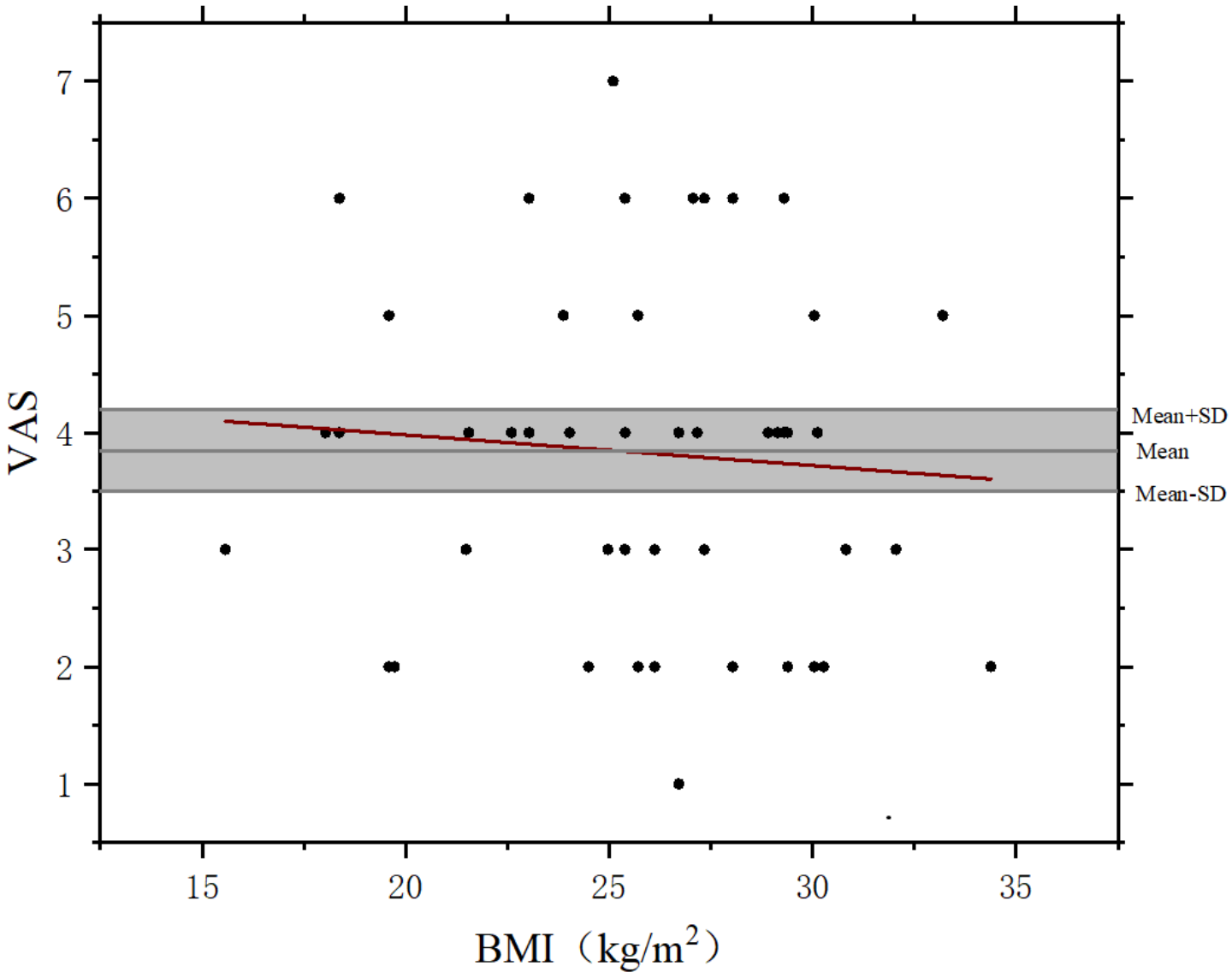

Figure 1

In patients reporting anterior knee pain after UKA, pain intensity according to the VAS was not significantly correlated with the BMI(r = 0.07, P =0.60)

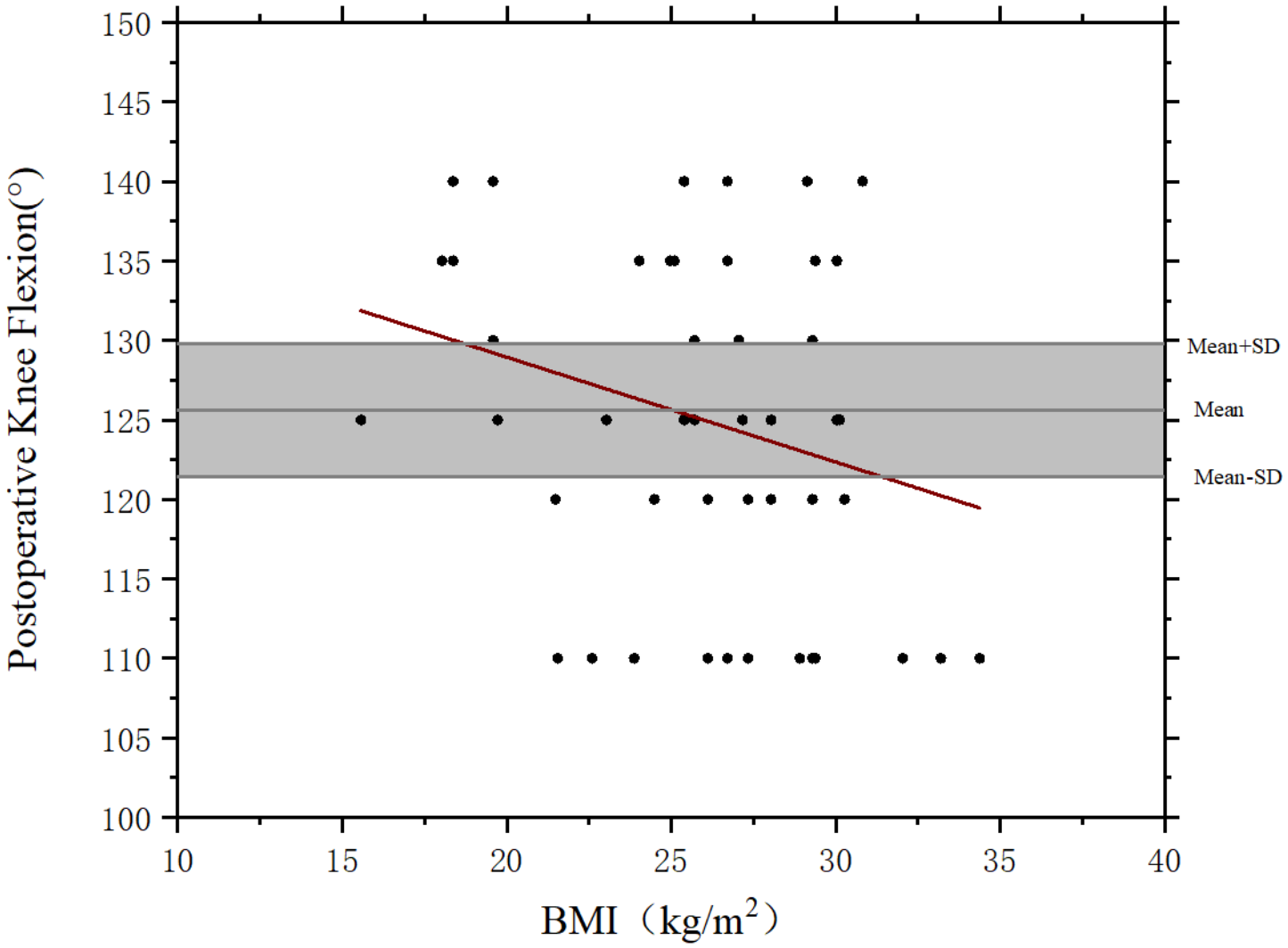

Figure 2

The postoperative knee flexion had not a significant correlation with BMI values in overweight and obese patients (r = 0.26 P = 0.06)

Figure 3

A-H X-ray findings before and after surgery.

(A-D) Preoperative X - ray and magnetic resonance imaging MRI showed the knee osteoarthritis.

(E-H) Positive X-ray (E) and lateral X-ray (F) examination at 1 day after operation showed the image performance after knee replacement. (G) Positive X-ray and lateral X-ray (H) examination at 3years after operation.