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Predictive value of bone mineral density for postoperative efficacy and factors influencing treatment outcomes in patients undergoing total hip arthroplasty: a retrospective study

X.-X. XU[1], X.-L. MEI[2], Y. QIU[1], Z.-Y. ZHOU[1], Z.-X. ZHANG[2], Z.-Q. REN[2]

[1]Department of Recovery Medicine, Jiangsu Taizhou People's Hospital, Taizhou, China
[2]Department of Orthopedics, Jiangsu Taizhou People's Hospital, Taizhou, China

Abstract. – OBJECTIVE: To investigate the value of bone mineral density (BMD) in predicting postoperative efficacy in patients undergoing total hip arthroplasty (THA), and to analyze the influencing factors of short-term outcomes.

PATIENTS AND METHODS: Clinical data, including general data, perioperative indicators, and postoperative follow-up information, were collected from patients undergoing THA from July 2018 to June 2020 at Jiangsu Taizhou People's Hospital for retrospective analysis. Using the Harris Hip Score (HHS) at 12 months after THA as the therapeutic effect evaluation index, the BMD levels of patients with different therapeutic effects were compared, and the correlation of BMD with therapeutic efficacy was analyzed. Furthermore, the influencing factors of postoperative efficacy were discussed by using a logistic regression model.

RESULTS: The HHS scores of 194 patients undergoing THA improved markedly at postoperative month 12 compared with the preoperative values ($p<0.05$), with a treatment excellent and good rate of 79.90% (155/194). The BMD level varied greatly among patients with different curative effects ($p<0.05$). Pearson correlation analysis identified a significant positive correlation between BMD values and HHS scores in patients undergoing THA. THA patients with different body mass index (BMI), surgical approach, occult blood loss, postoperative complications, length change of the affected limb, postoperative exercise time, and BMD had statistically significant differences in the excellent and good rate of clinical efficacy ($p<0.05$). According to the multivariate Logistic regression analysis, BMI, surgical approach, length change of the affected limb, and BMD were independent factors influencing the postoperative excellent and good rate of efficacy in THA patients ($p<0.05$).

CONCLUSIONS: Preoperative BMD levels are strongly correlated with postoperative efficacy improvement in patients undergoing THA. BMD is an independent influencing factor of excellent and good postoperative efficacy in patients undergoing THA, and increasing the BMD is conducive to improving outcomes in such patients.

Key Words:
Bone mineral density, Total hip replacement, Efficacy, Influencing factors

Introduction

Total hip arthroplasty (THA) is one of the major means to treat hip diseases caused by femoral neck fracture, femoral head necrosis, primary osteoporosis and other reasons. The therapeutic effects of the procedure have been well documented, which can effectively restore hip function and improve patients' quality of life, with significant clinical application value[1]. However, the postoperative efficacy of THA is influenced by multiple complicated factors and various surgical complications, seriously affecting the postoperative rehabilitation, follow-up treatment, and quality of life of post-surgical patients[2,3]. Bone mineral density (BMD), usually evaluated by dual-energy X-ray absorptiometry (DXA), is a clinical index of bone strength, and sufficient bone strength is a guarantee for maintaining bone integrity and resisting fractures. Due to the different metal materials and fixation modes of total hip prosthesis implanted during THA, patients are predisposed to periprosthesis osteolysis and bone after surgery, resulting in decreased BMD and reduced bone mass[4,5]. Moreover, several studies[6-8] have shown that BMD correlates with a higher risk of hip fracture. Low BMD of the hip joint affects prosthesis initial stability after THA, which

Corresponding Authors: Zhen-Xiang Zhang, MD; e-mail: zhangzhenxiang8438@163.com; Zhen-Qing Ren, MD; e-mail: renzhenqing8438@126.com

can lead to a decrease in prosthetic stability and an increase in revision rate, resulting in a shortened life span of the prosthesis and, ultimately surgical failure. Therefore, this study aimed to explore the correlation between preoperative BMD levels and short-term outcomes of patients after THA, and the factors that influence the excellent and good rate of clinical efficacy in such patients. This study helps determine the predictive value of BMD for hip function recovery after THA and provides a valuable reference for clinical application.

Patients and Methods

Source of Data

The clinical data of 194 patients undergoing THA at Jiangsu Taizhou People's Hospital from July 2018 to June 2020 were retrospectively analyzed. Criteria for patient enrollment: 1) patients who were confirmed by imaging (X-ray, computed tomography [CT] or nuclear magnetic resonance imaging [MRI]) to be eligible for THA, including primary osteoporosis, femoral neck fracture, femoral head necrosis, etc.; 2) patients who underwent THA within 3 to 7 days after admission; 3) patients who did not respond to conservative treatment and met the indications for THA with no contraindications; 4) patients who received their first unilateral THA; 5) patients with intact clinical data such as medical records and follow-up data. Criteria for patient exclusion: 1) those complicated by severe nerve injury, local or systemic infection, and severe organic diseases of the liver, kidney, heart, lungs, etc.; 2) patients with thyroid disorders or malignancies, or those undergoing ovariectomy or hysterectomy that affected bone metabolism; 3) patients who took drugs that affected bone metabolism 6 months before surgery or those with long-term use of hormones; 4) those who could not complete the investigation due to the combination of consciousness disorders, mental illness, etc.; 5) those with incomplete clinical data. Among the 94 patients undergoing THA, 82 were males and 112 were females, ranging in age from 47 to 85 years, with an average age of (65.58±8.69) years; the body mass index (BMI) ranged from 17.3 kg/m^2 to 32.6 kg/m^2, with a mean of (24.54±2.63); 68 cases were complicated with hypertension, 31 were combined with diabetes, and 45 were complicated by hyperlipidemia.

Surgical Contents

In all cases, the THA procedure was performed by professional joint surgeons in our hospital. Preoperative anesthesia included epidural and general anesthesia. Continuous epidural anesthesia: epidural puncture anesthesia was performed at L1~L2 or L2~L3 levels of the spine. General anesthesia was performed by intravenous-inhalation combined anesthesia. Anesthesia was induced by intravenous injection, maintained by isoflurane inhalation and intravenous fentanyl, and supported by injections of lidocaine or bupivacaine. An anterolateral or minimally invasive approach was selected as the surgical approach. After the hip joint exposure and the joint capsule's removal, the femoral neck was sawed 1.5 cm above the lesser trochanter of the femur for osteotomy. The residual soft tissue and cartilage wear in the acetabulum were filed and polished to ensure that its longitudinal axis was perpendicular to the lumbosacral joint. A total hip prosthesis was then placed to repair the femur and the joint was reduced. After confirmation of joint mobility and stability and the drainage tube placement, the incision was closed layer by layer.

Data Collection

All patients' general data (gender, age, BMI, etc.), BMD values, as well as perioperative data such as surgical anesthesia methods (epidural or general anesthesia), surgical approach (anterolateral or minimally invasive approach), operation time, intraoperative blood loss, incisional drainage, postoperative occult blood loss, postoperative complications, length change of the affected limb, and postoperative exercise time, were recorded. The BMD of patients was detected by an ultrasonic bone analyzer (GE Corp., Farmington, CT, USA) based on the principle of DXA. According to the World Health Organization (WHO) reference standards, normal BMD was defined as a t-value=±1.0, and osteopenia was defined as a t-value < -1.0 but ≥ -2.5; a t-value < -2.5 was suggestive of osteoporosis, and a t-value < -2.5 with osteoporotic fractures indicated severe osteoporosis.

Evaluation of Therapeutic Effects

The Harris Hip Score (HHS) was used to evaluate hip function recovery before and 12 months after THA. The scale includes four dimensions: pain (44 points), joint function (47 points), joint deformity (4 points), and range of motion (5 points), with a full score of 100. Evaluation criteria: 1) Excellent: HHS score ≥90; 2) Good: HHS score 80-89; 3) Fair: HHS score 70-79; Poor: HHS score <70; higher scores were linked to better hip function. Excellent and good rate of hip joint function = (excellent cases + good cases)/total cases *100%[9].

Statistics Analysis

The collected data were processed by SPSS 19.0 software (IBM Corp., Chicago, IL, USA). Measurement data were described as $\bar{x}$±s, and *t*-tests were performed for inter-group comparisons. Count data, represented by frequencies (n) and percentages (%), were analyzed using the χ^2 test. The Logistic regression model was used to analyze the influencing factors of excellent and good rate in terms of clinical efficacy in patients undergoing THA. $p<0.05$ was the significance threshold.

Results

Postoperative Therapeutic Effect of Patients Undergoing THA

The hip joint function of patients before and after THA was evaluated by HHS. The HHS score of the 194 patients was (38.02±7.66) before THA, and the score increased to (84.85±10.37) at 12 months after surgery, indicating significantly improved hip joint function of patients and marked therapeutic effects of THA. The four dimensions of HHS, including pain, joint function, joint deformity, and range of motion, showed statistically significant differences compared with preoperative scores ($p<0.05$). The details can be found in Table I.

BMD Levels in Patients with Different Efficacy

The HHS score at 12 months postoperatively was used as the index to evaluate the curative effect of THA. It was found that the curative effect was excellent (≥90 points) in 37.11% (72/194), good (80-89 points) in 42.78% (83/194), fair (70-79 points) in 12.89% (25/194), and poor (<70 points) in 7.22% (14/194). The BMD level varied greatly among patients with different curative effects ($p<0.05$), as shown in Table II and Figure 1. In addition, Pearson correlation analysis identified a positive relationship between BMD levels of THA patients and HHS scores (r=0.624, $p<0.05$).

Univariate Analysis of Postoperative Efficacy in Patients Undergoing THA

The HHS score ≥80 was used as an index to judge the excellent and good curative effects of patients undergoing THA, based on which an excellent and good rate of 79.90% (155/194) was calculated. Univariate analysis showed that there were significant differences in the excellent and good rate of THA patients with different BMI, surgical approach, occult blood loss, postoperative complications, length change of the affected limb, postoperative exercise time, and BMD ($p<0.05$). At the same time, the excellent and good rate had no significant correlation with age, sex, combined diseases and anesthesia mode ($p>0.05$). See Table III for details.

Univariate Analysis of Factors Affecting Efficacy in Patients Undergoing THA

With excellent and good curative effects after THA (no=0, yes=1) as the dependent variable and the statistically significant factors ($p<0.05$) in the univariate analysis as independent variables (the assignments are shown in Table IV), multivariate analysis was carried out using the Logistic regression model (Table V). It showed that BMI, surgical approach, occult blood loss, length change of the

Table I. Curative effect evaluation results of patients before and after THA ($\bar{x}$±s).

Dimension	Before surgery	12 months after surgery	*t*	*p*
Pain	15.61±5.02	40.24±8.92	33.516	<0.001
Joint function	20.17±5.91	38.18±7.82	25.592	<0.001
Joint deformity	1.2±0.34	2.64±0.89	21.052	<0.001
Range of motion	1.04±0.28	3.79±0.92	39.830	<0.001

Table II. BMD levels in patients with different therapeutic effects after THA ($\bar{x}$±s).

Indicators	Excellent	Good	Fair	Poor
BMD	-1.01±0.36	-1.75±0.56[a]	-2.01±0.62[ab]	-2.47±0.86[abc]

[a]$p<0.05$ *vs.* excellent group; [b]$p<0.05$ vs. excellent group; [c]$p<0.05$ *vs.* excellent group.

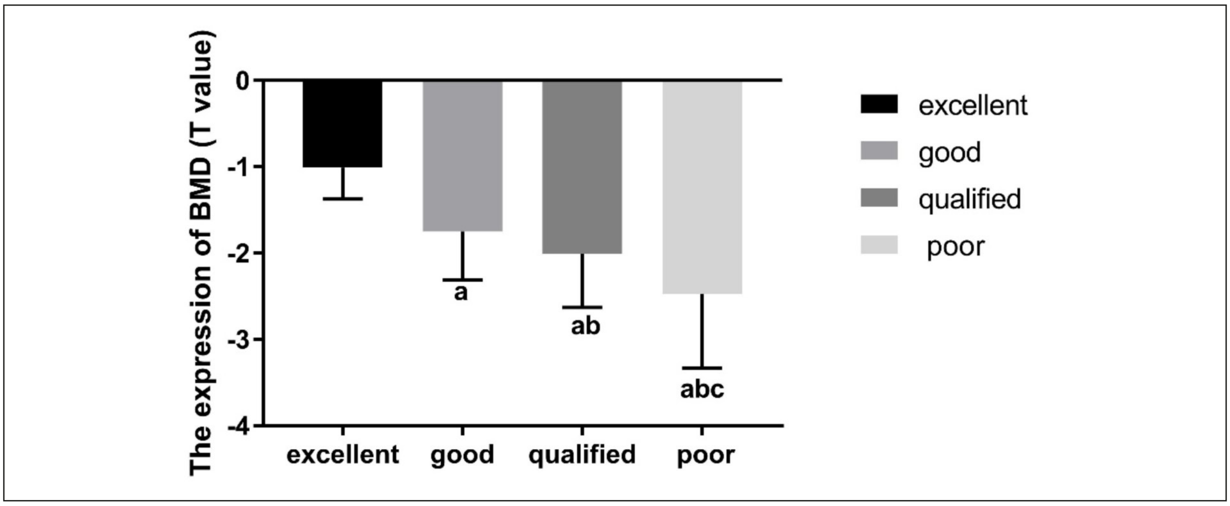

Figure 1. BMD levels in patients with different therapeutic effects. Compared with excellent group, [a]$p<0.05$; compared with the good group, [b]$p<0.05$; compared with the fair group, [c]$p<0.05$.

affected limb, and BMD were independent influencing the outcome after THA ($p<0.05$).

Discussion

Clinical reports indicate that THA, as an artificial hip joint reconstruction procedure, has been widely used to treat a variety of severe hip joint diseases with promising therapeutic outcomes. However, 20% of post-surgical patients still suffer from prosthesis loosening after THA, which ultimately leads to surgical failure[10]. In this study, the HHS was used to assess the postoperative hip function of patients undergoing THA. The results showed that the excellent and good rate (HHS score ≥80) was 79.90% at 12 months postoperatively, which was consistent with previous research. In order to investigate the influence of BMD on the postoperative curative effects of patients undergoing THA, this study further analyzed the correlation between the efficacy of THA patients and BMD levels. BMD levels varied significantly between patients with different responses. The higher the BMD level, the better the postoperative outcome of THA patients. Moreover, Pearson correlation analysis showed a significant positive correlation between BMD values and HHS scores in such patients. Hip BMD is an index that surgeons should pay special attention to when performing THA, and the decrease of BMD indicates a high risk of hip fractures[11]. The subsequent decline of bone quality will bring many problems to patients, such as intraoperative fracture, prosthesis loosening, and postoperative periprosthetic fracture risk[12]. According to WTO standards, a T-value of < -1.0 for BMD by DXA indicates osteopenia, while a T-value of <-2.5 suggests the presence of osteoporosis. Hip/knee replacement patients reported the bone loss of about 43.0% to 61.5% and osteoporosis of about 23% to 38.5%[13,14]. Adequate bone strength is a guarantee for maintaining bone integrity and resisting fractures. On the contrary, osteoporosis is associated with an elevated risk and surgical difficulty of THA, as well as a higher risk of postoperative fractures due to misalignment, traction discomfort, or violent manipulation[15]. Gregory et al[16] showed that patients with osteoporosis had a 5 to 8 times higher risk of fracture during and after joint replacement than non-osteoporotic patients. Labuda et al[17] also pointed out that patients waiting for joint replacement surgery are often complicated with osteoporosis. Thus, preoperative routine BMD testing is recommended.

Further, the multivariate Logistic regression analysis showed that BMI, surgical approach, occult blood loss, length change of the affected limb, and BMD were all independent factors influencing the rate of excellent and good postoperative outcomes in patients undergoing THA. The higher the BMI, the greater the patient's weight burden, and the more prominent the difficulty of rehabilitation exercise and joint pain following THA. In addition, Gross et al[18] proposed that low BMD combined with high BMI would increase the risk of early femoral head necrosis after hip resurfacing arthroplasty. Compared

Table III. Univariate analysis of postoperative efficacy in patients undergoing THA.

Classification	Number of cases (*n*)	Excellent group (n=155)		χ^2	*p*
		n	%		
Age (years old)				0.903	0.825
<55	35	27	77.14		
55-65	67	54	80.60		
66-75	59	49	83.05		
>75	33	25	75.76		
Gender				0.290	0.590
Male	82	67	81.71		
Female	112	88	78.57		
BMI (kg/m^2)				24.475	<0.001
<18.5	67	56	83.58		
18.5-23.9	72	67	93.06		
≥24.0	55	32	58.18		
Hypertension				0.765	0.382
Yes	68	52	76.47		
No	126	103	81.75		
Diabetes mellitus				0.747	0.387
Yes	31	23	74.19		
No	163	132	80.98		
Hyperlipidemia				0.688	0.407
Yes	45	34	75.56		
No	149	121	81.21		
Anesthesia mode				1.193	0.275
Epidural anesthesia	124	102	82.26		
General anesthesia	70	53	75.71		
Surgical approach				16.432	<0.001
Anterolateral approach	93	63	67.74		
Minimally invasive approach	101	92	91.09		
Operation time (min)				2.421	0.120
<80	81	69	85.19		
≥80	113	86	76.11		
Intraoperative blood loss (mL)				0.500	0.479
<320	75	58	77.33		
≥320	119	97	81.51		
Occult blood loss (mL)				13.206	<0.001
≤480	105	89	84.76		
>480	89	66	74.16		
Incisional drainage				1.448	0.229
Yes	118	91	77.12		
No	76	64	84.21		
Postoperative complications				10.046	0.002
Yes	59	47	79.66		
No	135	108	80.00		
Affected limb length change (mm)				17.928	<0.001
<10	87	79	90.80		
10-15	72	56	77.78		
>15	35	20	57.14		
Postoperative exercise time (h)				6.144	<0.001
<6	33	22	66.67		
6-10	121	97	80.17		
>10	40	36	90.00		
BMD				30.101	<0.001
Normal	30	28	93.33		
Osteopenia	89	80	89.89		
Osteoporosis	47	34	72.34		
Severe osteoporosis	28	13	46.43		

Table IV. Variable assignments.

Independent variable	Assignment method
BMI (kg/m^2)	<18.5=1; 18.5-23.9=2; ≥24.0=3
Surgical approach	Anterolateral approach=1; minimally invasive approach=2
Occult blood loss (mL)	≤480=1; >480=2
Postoperative complications	None = 0; yes =1
Length change of the affected limb (mm)	<10=1; 10-15=2; >15=3
Exercise time after operation	<6=1; 6-10=2; >10=3
BMD	1=normal; 2=osteopenia; 3=osteoporosis; 4=severe osteoporosis

Table V. Curative effect evaluation results of patients before and after THA ($\bar{x}$±s).

Influencing factor	β	SE	Wald χ^2	*p*	OR (95% CI)
BMI	-0.323	0.123	6.896	0.009	0.724 (0.569-0.921)
Surgical approach	0.534	0.229	5.438	0.020	1.706 (1.089-2.672)
Occult blood loss	-0.347	0.096	13.065	0.000	0.707 (0.586-0.853)
Postoperative complications	0.424	0.256	2.743	0.098	1.528 (0.925-2.524)
Length change of the affected limb	-0.617	0.212	8.470	0.004	0.540 (0.356-0.818)
Postoperative exercise time	0.756	0.394	3.683	0.055	2.130 (0.984-4.611)
BMD	-1.023	0.378	7.324	0.007	0.360 (0.171-0.754)

with the traditional external incision approach, minimally invasive approach causes less damage to the tissue surrounding the hip joint and reduces the amount of blood loss, which is conducive to wound healing and hip function recovery. Occult bleeding may lead to anemia due to weakened hematopoietic function. Without timely intervention, excessive blood loss can cause symptoms, such as mental burnout and loss of appetite, which are detrimental to the patient's postoperative recovery, nutrition, and health. Length change of the affected limb will not only cause inconvenience to patients' mobility and daily living but also induce greater psychological distress and serious psychological burden, which adversely affects their postoperative rehabilitation exercise and physiology and psychology, ultimately delaying rehabilitation. And the prosthesis implanted during THA may lead to femoral bone evacuation and cortical thinning due to the low BMD level of patients, resulting in a high likelihood of prosthesis loosening. Conversely, a relatively high level of BMD and complete bone structure can provide stronger support for the joint prosthesis.

Conclusions

Our study shows that BMD levels are closely related to postoperative efficacy in patients undergoing THA and can be a prognostic factor for such patients. Strengthening preoperative BMD testing and actively focusing on improving BMD levels can significantly improve the excellent and good rate of clinical efficacy in patients after THA, which is conducive to accelerating their postoperative recovery. This study still has certain limitations: given the limited number of cases included and the short follow-up time, a prospective study with a larger sample size is necessary to further unravel the influence of BMD levels on the long-term outcomes of patients undergoing THA.

Conflict of Interest

The Authors declare that they have no conflict of interests.

Informed Consent

Written informed content was signed and obtained by all participants.

Ethics Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional Jiangsu Taizhou People's Hospital, research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Ethics approval number: KY2022-137-01.

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Authors' Contributions

Xinxuan Xu conceived the study design and the content concept; Xiaoliang Mei,Yang Qiu,performed the data collection, extraction and analyzed the data. Zhenyu Zhou, Zhang Zhenxiang interpreted and reviewed the data and drafts. Ren Zhenqing reviewed the final draft.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

ORCID ID

Xinxuan Xu: 0009-0004-2049-3516.
Zhenyu Zhou 0009-0000-9273-5183.
Yangqiu 0009-0003-7710-7850.
Zhenqing Ren: 0000-0001-6960-2040.
Xiaoliang Mei: 0000-0002-3576-0419.
Zhenxiang Zhang: 0000-0001-9829-9861.

References

1) Golden SH, Vigilanec CP, Kao WH, Brancati FL. Preoperative glycemic control and risk of infectious complications in a cohort of adults with diabetes. Diabetes Care 1999; 22: 1408-1414.
2) Krinsley JS. Association between hyperglycemic and increased hospitalization in a heterogeneous population of critically ill patients. Mayo Clinic Proceedings 2003; 78: 1471-1478.
3) Yigit Ş, Akar MS, Şahin MA, Arslan H. Periprosthetic infection risks and predictive value of C-reactive protein / albumin ratio for total joint arthroplasty. Acta Biomed 2021; 92: e2021324.
4) Lambertz OC, Yagdiran A, Wallscheid F, Eysel P, Jung N. Periprosthetic infection in joint replacement. Dtsch Arztebl Int 2017; 114: 347-353.
5) Goh SL, De Silva RP, Dhital K, Gett RM. Is low serum albumin associated with postoperative complications in patient's under-going oesophagectomy for oesophageal malignancies? Interact Cardiovasc Thorac Surg 2015; 20: 107-113.
6) Bolognesi MP, Marchant MH, Viens NA, Cook C, Pietrobon R, Thomas PV. The impact of diabetes on perioperative patient outcomes after total hip and total knee arthroplasty in the United States. J Arthroplasty 2008; 23: 92-98.
7) Rizvi AA, Chiloag SA, Chiloag KJ. Peri-operative management of diabetes in hyperglycemia in patients undergoing orthopaedic surgery. J AAOS 2010; 18: 426-435.
8) Parvizi J, Gehrke T. International Consensus Group on Periprosthetic Joint Infection. Definition of periprosthetic joint infection. J Arthroplasty 2014; 29: 1331.
9) Arampatzis S, Frauchiger B, Fiedler GM, Leichtle AB, Buhl D, Schwarz C, Georg CF, Heinz Z, Aristomenis KE, Gregor L. Characteristics, symptoms, and outcome of severe dysnatremias present on hospital admission. Am J Med 2012; 125: 1125.e1-1125.e7.
10) Tande AJ, Patel R. Prosthetic joint infection. Clin Microbiol Rev 2014; 27: 302-345.
11) Momohara S, Kawakami K, Iwamoto T, Yono K, Sakuma Y, Hiroshima R, Imamura H, Masuda I, Tokita A, Ikari K. Prosthetic joint infection after total hip or knee arthroplasty in rheumatoid arthritis patients treated with nonbiologic and biologic disease-modifying antirheumatic drugs. Mod Rheumatol 2011; 21: 469-475.
12) Jämsen E, Nevalainen P, Eskelinen A, Kaisa H, Jarkko K, Teemu M. Obesity, diabetes, and preoperative hyperglycemia as predictors of periprosthetic joint infection: a single-center analysis of 7181 primary hip and knee replacements for osteoarthritis. J Bone Jt Surg Am 2012; 94: e101.
13) Jeon CY, Furuya EY, Berman MF, Larson EL. The role of pre-operative and post-operative glucose control in surgical-site infections and mortality. Plos One 2012; 7: e45616.
14) Marchant MH, Viens NA, Cook C, Thomas PV, Michael PB. The impact of glycemic control and diabetes mellitus on perioperative outcomes after total joint arthroplasty J Bone Joint Surg Am 2009; 91: 1621-1629.
15) Jamsen E, Nevalainen P, Kalliovalkama J, Teemu M. Preoperative hyperglycemia predicts infected total knee replacement. Eur J Intern Med 2010; 21: 196-201.
16) King JT, Goulet JL, Perkal MF, Ronnie AR. Glycemic control and infections in patients with diabetes undergoing noncardiac surgery. Ann Surg 2011; 253: 158-165.
17) Mendez CE, Mok KT, Ata A, Robert JT, Jorge CE, Guillermo EU. Increased Glycemic Variability Is Independently Associated With Length of Stay and Mortality in Noncritically Ill Hospitalized Patients. Diabetes Care 2013; 36: 4091-4197.
18) Han HS, Kang SB. Relations between long-term glycemic control and postoperative wound and infectious complications after total knee arthroplasty in type 2 diabetics. Clin Orthop Surg 2013; 5: 118-123.

19) Iwata M, Kuzuya M, Kitagawa Y, Iguchi A. Prognostic value of serum albumin combined with serum C-reactive protein levels in older hospitalized patients: continuing importance of serum albumin. Aging Clin Exp Res 2006; 18: 307-311.
20) Greene KA, Wilde AH, Stulberg BN. Preoperative nutritional status of total joint patients. Relationship to postoperative wound complications. J Arthroplasty 1991; 6: 321-325.
21) Huang R, Greenky M, Kerr GJ, Matthew SA, Javad P. The effect of malnutrition on patients undergoing elective joint arthroplasty. J Arthroplasty 2013; 28: 21-24.
22) Si HB, Zeng Y, Shen B, Jing Y, Zhou Z, Kang P, Pei F. The influence of body mass index on the outcomes of primary total knee arthroplasty. Knee Surg Sport Traumatol Arthrosc 2015; 23: 1824-1832.
23) Claus A, Asche G, Brade J, Schwenkglenks MB, Horchler H, Müller JF, Schumm W, Weise K, Scharf HP. Risk profiling of postoperative complications in 17,644 total knee replacement. Der Unfallchirurg 2006; 109: 5-12.
24) Namba RS, Inacio MC, Paxton EW. Risk factors associated with deep surgical site infections after primary total knee arthroplasty. J Bone Jt Surg Am 2013; 95: 775-782.