CLINICAL ARTICLE

Hip Preservation or Total Hip Arthroplasty? A Retrospective Case–Control Study of Factors Influencing Arthroplasty Decision-Making for Patients with Osteonecrosis of the Femoral Head in China

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Objective: At present, there is no consensus or guidance on indications for osteonecrosis of the femoral head (ONFH) patients to receive hip arthroplasty (THA) treatment. This study aims to explore the factors that influence the decision-making for THA in patients with ONFH, and to provide references for clinical decision for ONFH patients to be indicated for THA or hip preservation.

Methods: This retrospective case–control study involved data for ONFH patients from July 2016 to October 2021 from the China Osteonecrosis of the Femoral Head Database (CONFHD). The patients with ONFH, and unilateral hip affected at the first visit were divided into THA group and non-THA group according to if they had undergone THA treatment. The differences between the two groups of patients in terms of gender, age at the time of consultation, body mass index (BMI), etiology, onset side, association research circulation osseous (ARCO) stage, hip joint function, visual analog scale (VAS), etc. were analyzed. Multivariate binomial logistic regression analysis was then applied to evaluate the risk factors of ONFH patients who underwent THA during the first visit.

Results: A total of 640 patients were recruited for analysis, including 209 cases from the THA group and 431 cases from the non-THA group. The results of univariate analysis showed that the two groups of patients were significantly different in the following six indicators: age (59 vs. 46, $Z = -9.58$, $p < 0.001$), duration of disease (78 vs. 17, $Z = -16.14$, $p < 0.001$), gender composition ($\chi^2 = 8.09$, $p = 0.004$), disease etiology ($\chi^2 = 33.04$, $p < 0.001$), ARCO stage ($\chi^2 = 334.86$, $p < 0.001$), flexion of hip joint ($\chi^2 = 172.33$, $p < 0.001$). However, the comparison between the two groups on VAS ($Z = -0.82$, $p = 0.41$), BMI ($Z = -1.35$, $p = 0.18$), and onset side ($\chi^2 = 1.53$, $p = 0.22$) did not obviously differ. The results regression analysis showed that the age at the time of consultation, duration of disease, ARCO stage, and the hip joint function affected the decision making if the patients should undergo THA. The results of receiver operating characteristic curve (ROC) analysis showed that aforementioned indicators were satisfactory in predicting whether patients with ONFH would be treated with THA. The regression model

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using the above four indicators as comprehensive indicators has satisfactory performance in predicting whether to perform THA, and the area under the curve (AUC) is 93.94%.

Conclusion: These factors such as age, duration of disease, ARCO stage, and hip flexion function should be considered comprehensively before making decisions to perform THA or not in our clinical practice.

Key words: Hip Arthroplasty; Hip Preservation; Osteonecrosis of the Femoral Head; Risk Factor; Treatment Decision

Introduction

As a common intractable disease in orthopaedics, the pathological feature of osteonecrosis of the femoral head (ONFH) is that the disruption of the vascular supply of the subchondral bone, leading to the death of osteocytes and collapse of the articular surface of the femoral head.[1–4] ONFH involves not only complicated pathogenesis but also constantly makes orthopaedists face the complicated decision of selecting treatment modalities.[5–8] The surgical treatment of ONFH can be summarized into two categories: joint arthroplasty surgery and hip preservation surgery. Joint arthroplasty is considered an effective treatment for ONFH in advanced stages, particularly when secondary arthritis is presented.[5] Total hip arthroplasty (THA) is commonly considered to be an effective surgical treatment, and its efficacy has been affirmed in many ways.[9–11] However, THA is accompanied with several side effects, such as postoperative prosthesis loosening, periprosthesic infection, deep vein thrombosis, etc.[12–14] Many young patients have poor long-term results, shorten implant survival time, and have a higher revision rate.[15] For young patients or those who have not yet experienced secondary acetabular changes, delaying the time to undergo THA has great significance. Therefore, it is vital to choose the right patient for hip preservation treatment and the right patient for THA. To date, the traditional considerations of most clinicians are still made via clinical presentation, plain radiographs, and advanced imaging such as MRI, etc. have guided arthroplasty decision-making, but they are still unclear about the boundaries of indications.

Cui et al.[16] reported a huge database of 6395 inpatients from nine large tertiary hospitals in China and found that 30.5% of THA was performed because of ONFH. The rate of THA in patients with ONFH has increased compared with the number of hip preservation surgery cases, and the proportion of THA has increased from 76% in the early 1990s to 88% in 2010.[17] Therefore, it is particularly important to pay attention to implant survival in young and physically active patients. It is reported that around 90% of arthroplasties will survive up until 15 years and around 85% will last around 20 years after surgery due to implant wear or failure. What's more, joint arthroplasty surgery is associated with medical and socioeconomic burdens in China and globally as well.

For treatment of ONFH, arthroplasty decision-making is usually challenging, and the clinical boundary between hip preservation and THA is often unclear. Based on clinical observation and experience, we found that the decision-making between different treatment options may be related to many factors, including patient age, gender, disease stage, pain, and joint function, but no research reports specifically addressing this issue are available in the literature. We found a series of studies from the China Osteonecrosis of the Femoral Head Database (CONFHD, http://onfh.keyanyun.com),[18] that one of the studies mainly focused on the population and clinical characteristics of ONFH patients who underwent THA, such as age, BMI, etiological composition, and ARCO stage distribution. There was also a report that showed restrictions in hip function that was more important than hip pain for indicating THA treatment.[19] However, the factors affecting the choice of THA or hip-preserving therapy in patients with ONFH have not yet been explored. Hence, we conducted this current retrospective case–control study to: (i) explore the factors that might influence the decision-making of ONFH patients for undergoing THA or hip-preserving treatment, (ii) in addition to clarifying clinical indications of THA (iii) and providing references for clinical practice of treating ONFH.

Materials and Methods

Study Design

This study was based on the online application of CONFHD, where we have published research results on the epidemiology, misdiagnosis factors, treatment modalities[19–22] of ONFH. The CONFHD program was established in 2015 with the purpose of improving the medical management of ONFH patients in mainland China. The CONFHD program planned to recruit over 2400 ONFH patients (200 patients for each sampling area) with joint efforts of 25 public hospitals from 12 administrative areas (provinces or municipalities) across mainland China. The sampling areas included Beijing municipality, Shanghai municipality, Shandong province, Henan province, Guangxi province, Shan'xi province, Guangdong province, Jiangsu province, Fujian province, Hubei province, and Jilin province. We retrospectively analyzed the clinical data of patients with ONFH who were hospitalized in these hospitals from July 2016 to October 2021. We screened and analyzed the clinical data of 640 patients who met the inclusion and exclusion criteria among the 1783 hospitalized patients with ONFH and detailed screening process of participants were shown in Figure 1. This study was approved by the Ethics Committee of Wangjing

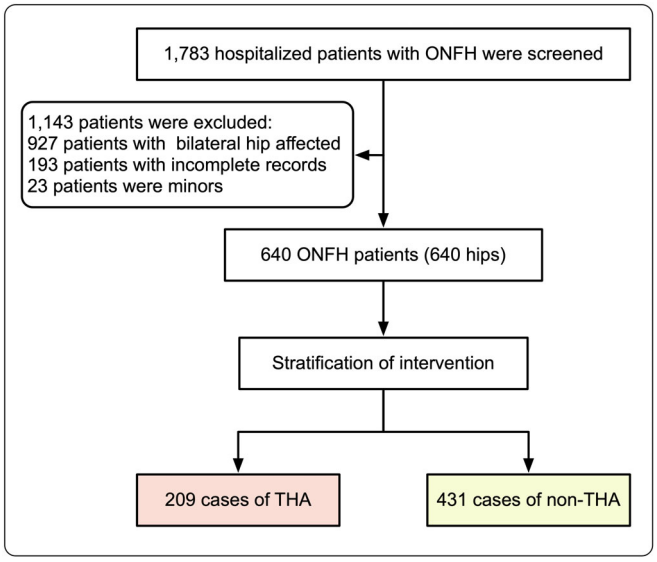

FIGURE 1 Flowchart detailing the screening and baseline characteristics of 640 ONFH patients. ARCO, association research circulation osseous; ONFH, osteonecrosis of the femoral head

Hospital, China Academy of Chinese Medical Sciences (No. 2008K715). Well-trained research assistants were engaged in data entry, however without being involved in any medical management of ONFH patients. All data were decoded before being analyzed and presented. The attending doctors for the patients were also not involved in this study. Three orthopaedic surgeons who specialized in hip arthritis but were not involved in the present study were invited to evaluate the images. Decisions were made by consensus among three surgeons.

The diagnosis of ONFH was performed based on distinctive radiographic features seen on magnetic resonance imaging (MRI), including a focal serpentine low signal line with fatty center on T1 weighted image (reactive interface line), and serpiginous peripheral dark line and inner bright line on T2 weighted image (double line sign), according to the Association Research Circulation Osseous (ARCO) classification system[23] (schematic diagram of ARCO staging based on antero-posterior images shown in Figure 2). The inclusion criteria were: (1) patients who were confirmed diagnosed with ONFH, (2) an age of 18 years old and above, (3) patients with unilateral hip affected, and (4) record of the first visit. Exclusion criteria were: (1) patients with incomplete records and (2) duplicate data.

Data Structure and Classification

In this study, we only collected the following clinical data of patients with ONFH when they were admitted to the foregoing hospitals for analysis: gender, age at the time of consultation, duration of disease, body mass index (BMI), causes of ONFH, onset side, ARCO stage, the function of the hip joint, visual analog scale (VAS), whether to undergo THA. In the assessment of pain and joint function in patients with bilateral onset, accurate evaluation of the contralateral side might be confounded. In order to avoid potential bias, this study only included patients with unilateral ONFH. We categorized the etiology of ONFH into traumatic or non-traumatic ONFH. Concerning the function of the hip joint, we selected our previous evaluation method of clinical efficacy indicators for hip preservation treatment proposed based on the core outcome set concept.[24] This assessment method covers the four dimensions of pain, hip flexion, walking distance, and stable rating of X-ray images.[25] In this study, two indices of pain and hip flexion were used to analyze related factors. Due to the lack of information on walking distance in the original data, walking distance was not included in the analysis, and the stable rating of X-ray images (defined as follows: the necrotic area of the femoral head had a similar or the same morphology before and after treatment, the necrotic area showed that bone density had increased, cystic size was reduced, and the sclerosis zone was blurred) was used as a comparative indicator before and after treatment, so it was not included in the analysis either.

We divided age into three categories: (1) age ≤ 40 years old, (2) 40 < Age ≤ 60 years old, and (3) Age > 60 years old, and duration of disease into four phases: (1) duration ≤ 12 month, (2) 12 < duration ≤ 36 month, (3) 36 < duration ≤ 60 month, and (4) duration > 60 month.

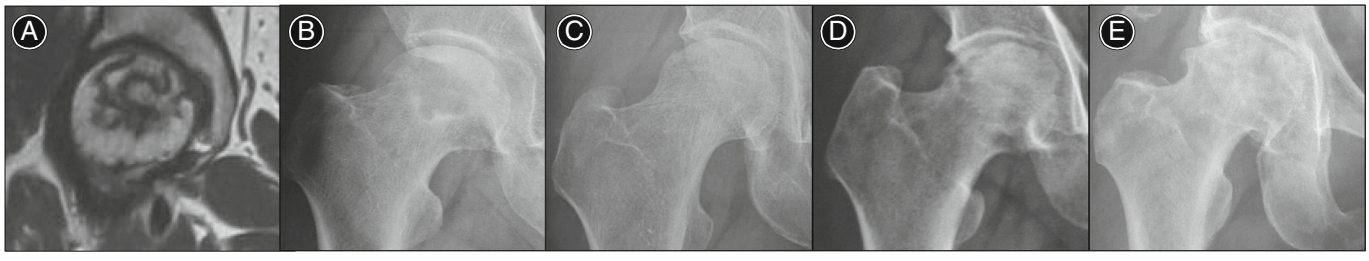

FIGURE 2 Antero-posterior images of the right hip of a ONFH patient progressed from ARCO stage I to IV. (A) stage I: a low-intensity outer rim on T1-weighted coronal MR image is noted, (B) stage II: focal osteoporosis and osteosclerosis are seen in the femoral head, (C) stage IIIA: subchondral collapse lesser than 2 mm and marginal sclerosis along the lesion are seen, (D) stage IIIB: marked collapse of femoral head more than 2 mm is noted, and (E) stage IV: fragmentation of the necrotic lesion and progress of the joint space narrowing with acetabular change are seen

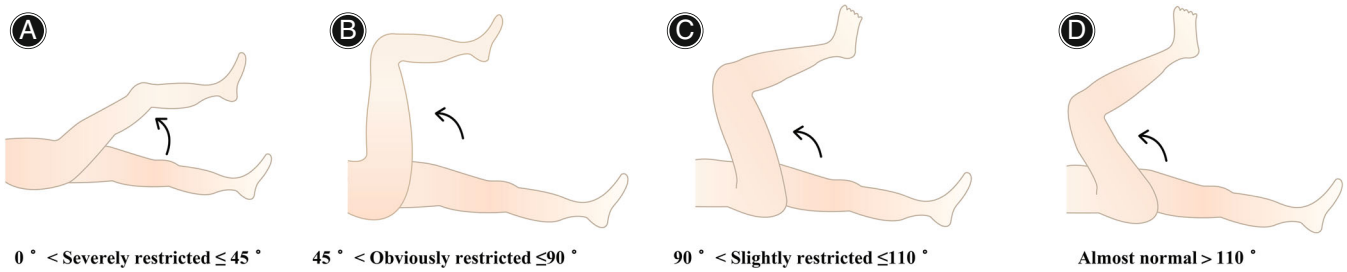

FIGURE 3 Schematic diagram of the severity of restriction in hip flexion

we also divided hip flexion into four grades: (1) severely restricted: 0° < flexion ≤ 45°, (2) obviously restricted: 45 < flexion ≤ 90°, (3) slightly restricted: 90° < flexion ≤ 110°, and (4) almost normal: flexion > 110° (Figure 3). Patients were divided into group of cases or controls according to if they underwent THA.

Statistical Analysis

Medians and the interquartile range (IQR) were used to represent non-normal distribution continuous data, and frequency distributions were used to represent categorical data. If the continuous variable satisfied the normal distribution and the homogeneity of variance, one-way analysis of variance (ANOVA) was used, or otherwise, Mann–Whitney U-test was used. Categorical variables were evaluated by chi-square test or Fisher's exact tests. Binary Logistic regression was performed on the statistically significant variables in the univariate analysis. The variable inclusion standard was 0.05, and the elimination standard was 0.10. $p \leq 0.05$ was considered as statistical significance of the difference. The receiver operating characteristic curve (ROC curve) analysis was conducted to estimate the performance of the studied indicators on the prediction of whether perform THA as treatment modalities.

Results

Characteristics of ONFH Patients

We screened out 640 cases from 1783 ONFH patients for analysis (Table 1), of which 209 (32.66%) cases were treated with THA and another 431 (67.34%) cases underwent other treatment modalities. There were 437 (68.28%) males and 203 (31.72%) females, with a median age of 50 (20) years old (range from 18 to 88 years old), median duration of disease of 34 (58) months (range from 0.3 to 180 months), and a median BMI value of 24.57 (3.92) (range from 18.35 to 35.29). According to the classification of the etiology, there were 158 (24.69%) cases of traumatic ONFH and 482 (75.31%) cases of non-traumatic ONFH, 65 (10.16%) cases of ARCO stage I, 238 (37.19%) cases of stage II, 192 (30.00%) cases of stage III, and 145 (22.65%) cases of stage IV. There were 44 (6.88%) cases with a 0° < flexion ≤ 45°, 192 (30.00%) cases with a 45 < flexion ≤ 90°, 207 (32.34%) cases with a 90° < flexion ≤110°, and 197 (30.78%) cases with a flexion >110°. The median VAS for these patients was 5.00 (2.00) (range from 1.00 to 9.00).

Univariate Comparisons of ONFH Patients with or without THA between the Group of Cases and Controls

Nine potential influencing factors were compared between the group of cases and controls. The results showed that in terms of age or duration of disease, there was a significant difference (59 vs. 46, $Z = -9.58$, $p < 0.001$) in the median

TABLE 1 The detailed characteristics of included participants

Item	Median (IQR) [range]	Number of cases (%)
Group		
Group of cases (THA)	–	209 (32.66)
Group of controls (non-THA)	–	431 (67.34)
Age (years)	50 (20) [18–88]	–
Duration of disease	34 (56) [0.3–180]	–
Gender		
Male	–	437 (68.28)
Female	–	203 (31.72)
BMI (kg/m^2)	24.57 (3.84) [18.35–35.29]	–
Etiology		–
Traumatic	–	158 (24.69)
Non-traumatic	–	482 (75.31)
Onset side		
Left	–	290 (45.31)
Right	–	350 (54.69)
ARCO stage		
Stage I	–	65 (10.16)
Stage II	–	238 (37.19)
Stage III	–	192 (30.00)
Stage IV	–	145 (22.65)
Hip joint flexion		
0° < flexion ≤ 45°	–	44 (6.88)
45° < flexion ≤ 90°	–	192 (30.00)
90° < flexion ≤ 110°	–	207 (32.34)
Flexion > 110°	–	197 (30.78)
VAS	5.00 (2.00) (1.00–9.00)	–

Abbreviations: ARCO, association research circulation osseous; BMI, body mass index; IQR, interquartile range; THA, total hip arthroplasty; VAS, visual analog scale.

age, and significant difference (78 vs. 17, Z = −16.14, $p < 0.001$) in the median duration of disease between the cases group and the controls group, and there were also differences ($\chi^2 = 8.09$, $p = 0.004$) in gender composition between the two groups, and there were also differences between the two groups in the etiological component ratio ($\chi^2 = 33.04$, $p < 0.001$), ARCO stage ($\chi^2 = 334.86$, $p < 0.001$), and hip joint flexion ($\chi^2 = 172.33$, $p < 0.001$). However, there was no significant difference between the case group and the control group in terms of VAS (Z = −0.82, $p = 0.41$), BMI (Z = −1.35, $p = 0.18$), and onset side ($\chi^2 = 1.53$, $p = 0.22$). The detailed comparison results of the case group and the control group are shown in Table 2.

Binary Logistic Regression Analysis of ONFH Patients With or Without THA from the Group of Cases and Controls

The analysis method of binary logistic regression was performed for ONFH patients, where with THA was regarded as the dependent variable, and the factors with statistical significance in the univariate analysis were regarded as the independent variable. The results of binary logistic regression analysis showed that age, duration of disease, ARCO stage, and hip flexion affect the surgeon's recommendation for THA treatment (Table 3), the age of patient with ONFH was proportional to risks involved in receiving THA treatment. Compared with age ≤ 40 years old, patients with 40 < age ≤ 60 years old ($p = 0.002$, $OR = 3.60$, 95% CI = 1.60–8.09) and age > 60 years old ($p < 0.001$, $OR = 4.75$, 95% CI = 1.99–11.31) increased gradually in the possibility of them choosing THA treatment. In terms of duration of disease, compared with duration ≤12 month, patients with 12 < duration ≤ 36 month ($p = 0.026$, $OR = 3.36$, 95% CI = 1.16–9.74), 36 < duration ≤ 60 month ($p = 0.007$, $OR = 4.88$, 95% CI = 1.56–15.28), and duration >60 month ($p < 0.001$, $OR = 15.87$, 95% CI = 5.12–49.17) gradually increased the possibility of choosing THA treatment. ARCO Stage IV was a risk factor for patients with ONFH, who tended to be treated with THA ($p = 0.001$, $OR = 19.38$, 95% CI = 3.40–110.52); Compared with hip joints flexion >110°, patients with 90° < flexion ≤ 110° ($p = 0.006$, OR = 3.75, 95% CI = 1.47–9.55), 45 < flexion ≤ 90° ($p < 0.001$, OR = 6.10, 95% CI = 2.37–15.70), and 0° < flexion ≤ 45° ($p < 0.001$, OR = 26.36, 95% CI = 7.24–95.96) gradually increased the possibility of accepting THA treatment. Gender and etiology of disease were removed from the regression model due to the lack of correlation. The regression model that integrated age, duration of disease, ARCO stage, and hip flexion was then used as a composite index to predict if the patients would accept THA in further analysis. The probability equation using the regression model was as follows:

$$P = \frac{e^{\text{logit(P)}}}{1 + e^{\text{logit(P)}}}$$

TABLE 2 Univariate analysis of ONFH patients who underwent THA as treatment modality

Item	Group of cases (THA)	Group of controls (non-THA)	$t/\chi^2/Z$-value	p-value
Age (years)	59 (17)	46 (18)	Z = −9.58	$p < 0.001$
Gender				
Male	127 (60.77%)	310 (71.93%)	$\chi^2 = 8.09$	$p = 0.004$
Female	82 (39.23%)	121 (28.07%)		
Duration of disease	78(36)	17(34)	Z = −16.14	$p < 0.001$
Onset side				
Left	102 (48.80%)	188 (43.62%)	$\chi^2 = 1.53$	$p = 0.22$
Right	107 (51.20%)	243 (56.38%)		
BMI	24.22 (3.53)	24.68 (3.96)	Z = −1.35	$p = 0.18$
Etiology				
Traumatic	81 (38.76%)	77 (17.87%)	$\chi^2 = 33.04$	$p < 0.001$
Non-traumatic	128 (61.24%)	354 (82.13%)		
VAS	5 (2)	5 (2)	Z = −0.82	$p = 0.41$
ARCO stage				
Stage I	2 (0.96%)	63 (14.62%)	$\chi^2 = 334.86$	$p < 0.001$
Stage II	16 (7.66%)	222 (51.51%)		
Stage III	57 (27.27%)	135 (31.32%)		
Stage iv	134 (64.11%)	11 (2.55%)		
Hip joint flexion				
0° < flexion ≤ 45°	36 (17.22%)	8 (1.86%)	$\chi^2 = 172.33$	$p < 0.001$
45 < flexion ≤ 90°	107 (51.20%)	85 (19.72%)		
90° < flexion ≤ 110°	59 (28.23%)	148 (34.34%)		
Flexion > 110°	7 (3.35%)	190 (44.08%)		

Abbreviations: ARCO, association research circulation osseous; BMI, body mass index; THA, total hip arthroplasty; VAS, visual analog scale.

TABLE 3 Binary logistic regression analysis of risk factors

Item	B	SE	Wald	*p*	OR	95% CI	
						Lower	Upper
Age (years)	–	–	13.08	0.001	–	–	–
40 < Age ≤ 60	1.28	0.41	9.62	0.002	3.60	1.60	8.09
Age > 60	1.56	0.44	12.43	<0.001	4.75	1.99	11.31
Duration of disease (month)	–	–	28.13	<0.001	–	–	–
12 < duration ≤ 36	1.21	0.54	4.96	0.026	3.36	1.16	9.74
36 < duration ≤ 60	1.59	0.58	7.41	0.007	4.88	1.56	15.28
Duration > 60	2.76	0.58	22.94	<0.001	15.86	5.12	49.17
ARCO stage	–	–	46.66	<0.001	–	–	–
Stage II	−0.008	0.83	0.000	0.99	0.99	0.19	5.06
Stage III	0.47	0.84	0.32	0.57	1.61	0.31	8.31
stage IV	2.96	0.89	11.14	0.001	19.39	3.40	110.52
Hip joint flexion (°)	–	–	26.96	<0.001	–	–	–
0° < flexion ≤ 45°	3.27	0.66	24.63	<0.001	26.36	7.24	95.96
45° < flexion ≤ 90°	1.81	0.48	14.06	<0.001	6.10	2.37	15.70
90° < flexion ≤ 110°	1.32	0.48	7.65	0.006	3.75	1.47	9.55
Constant	−5.78	0.93	38.55	<0.001	0.003	–	–

Abbreviations: ARCO, association research circulation osseous; OR, odds ratio; SE, standard error; 95% CI, 95% confidence interval.

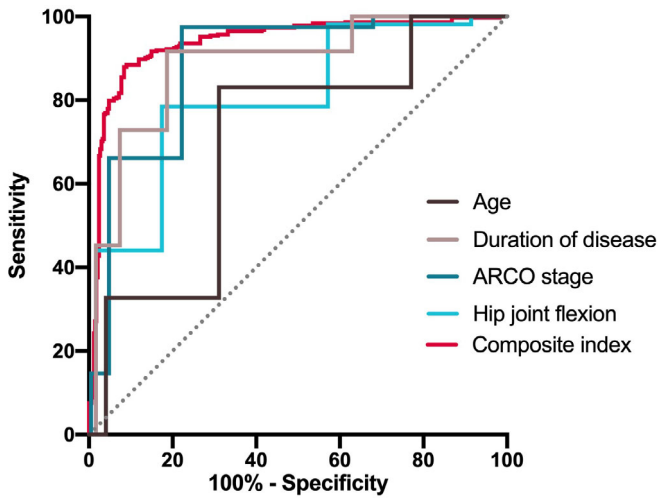

FIGURE 4 The ROC curves of different indicators for ONFH patients to predict the acceptance for THA

Predictive Performance of Various Indicators

The area under the curves shown in Figure 4 represented the capacity of different prediction indicators for predicting ONFH patients if they underwent THA as a treatment modality. Several indicators, such as age, duration of disease, ARCO stage, and hip joint flexion, had a satisfactory performance in their predictive ability for accepting THA (Table 4). We found the regression model integrating the age, duration of disease, ARCO stage, and hip flexion as a composite index had a satisfactory performance on predicting whether to perform THA, with an AUC of 93.94%.

Discussion

This study explored and summarized the influencing factors of ONFH patients receiving THA treatment. From the various demographic characteristics, clinical symptoms, imaging indicators, and many other potential influencing factors of ONFH patients at the time of first visit, it was explored that ONFH patients who undergo THA treatment recommendations are the most important influencing factors, including four indicators such as the age at the time of consultation, the duration of disease, the ARCO stage, and the hip joint flexion.

The Factors that Influence the Decision-Making of THA in ONFH Patients Have Received Little Attention

According to our observations, most researchers in orthopaedic clinics are paying attention to the efficacy of THA.[26,27] A few scholars have published studies related to the clinical characteristics of patients undergoing THA for the first time.[28–31] However, the results of these studies are mostly focused on summarizing the demographic characteristics of the included cases such as gender, etiological composition, age distribution, and almost no other indicators related to the patient's condition at the time of admission, such as clinical symptoms, staging, imaging manifestations, etc. None paid much attention to the determinants that influence the outcome of THA as the first choice of treatment. This may be due to long-term clinical experience showing that for those symptomatic and femoral head collapsed patients, especially when secondary acetabular changes are noted, THA has always been their best treatment option. Among patients with ONFH, the proportion of patients receiving THA treatment is relatively high. Data from 2010–2013 in mainland China show that for every

TABLE 4 Area under the ROC curve of prediction methods with different indicators

Indicator	Area under the ROC curve	*p*	95% CI
Age	0.69	<0.001	0.65–0.74
Duration of disease	0.88	<0.001	0.85–0.91
ARCO stage	0.88	<0.001	0.85–0.91
Hip joint flexion	0.80	<0.001	0.76–0.83
Composite index	0.94	<0.001	0.91–0.96

20,000 patients with ONFH, 6000 patients received THA treatment.[16] In the United States, the rate of THA treatment for patients with ONFH has increased from 75% to 88% in 10 years.[17] In the long-term clinical practice, we have noticed that ONFH patients receiving THA treatment are relatively young,[20] and have a broad grasp of THA indications, and no strict indications have been formed.

Pain Is Not the Main Factor that Affects Whether Patients With ONFH Undergo THA

In this study, we compared nine indicators, including gender, age, BMI, duration of disease, etiology, onset side, VAS, ARCO stage, and hip flexion at the time of the patient's first visit. The results of univariate analysis found that the difference between the THA group and the non-THA group was not significant in the comparison of the onset side, BMI, and VAS scores. This result is also similar to that of our previous study.[19] This result indicated that pain was not a decisive factor for patients whether receiving THA treatment. Analysis of the reasons may be related to the current status of various methods of treating ONFH in China.[22,32–34] In addition, in mainland China, acupuncture, massage, and Chinese medicine are widely accepted by patients for treatment of various disorders and are relatively cost-effective. Concerning pain, ONFH patients may have a number of options for pain relief treatments and the related pain problem can even be solved in community hospitals or clinics. In addition, age was also an important factor that affects the decision for performing THA or not. In our study, the median age of patients in the THA group was 59 years old, while the median age of patients in the non-THA group was 46 years old, which was in line with that documented clinically.

The Duration of Disease Has an Important Impact on Whether Patients with ONFH Undergo THA

The duration of disease course also has an important impact on making treatment decisions. This study divided the length of the patient's disease course into four stages, that is ≤12 months, 12–36 (including 36 months), 36–60 (including 60 months), and >60 months. Compared with the patient's disease course ≤12 months, the risk of replacement in the course of 12–36 months (including 36), 36–60 months (including 60), and >60 months is sequentially higher. For patients with a disease course of more than 5 years, the probability of receiving THA treatment is nearly 15 times higher than that of patients with a course of <1 year. The possible reason was that patients with a longer course of the disease were eventually treated with THA to obtain a better quality of life due to the progress of the disease, increase in age, the failure of hip-preserving treatment, and the secondary hip joint osteoarthritis.

ARCO Staging Has an Important Impact on Whether Patients with ONFH Undergo THA

Our current study shows that ARCO Stage IV was an absolute risk factor for ONFH patients to undergo THA, which is also in line with our routine clinical practice. The femoral head collapse is more serious in patients with ARCO stage IV and is often accompanied by secondary hip osteoarthritis. Hence, THA is regarded as the best treatment option for patients at this stage. While ARCO stage II and stage III cannot be the determinant of THA, which may be related to the shorter course of the patient's disease, the earlier stage of the disease, and the current status of hip-preserving treatment in China. We also observed that there were two patients with stage I and 16 patients with stage II in the THA group. This was not consistent with clinical observation. The possible reason could be that these patients were generally over 65 years old, elderly patients are considered to have a lower success rate of hip preservation due to decreased bone regeneration ability. Secondly, because of moderate or higher pain, the flexion of the hip joint in these patients was generally in a severely restricted range. Based on the above factors, doctors and patients may be more prone to THA when making treatment decisions.

The function of the hip joint (hip joint flexion) affects treatment decisions. Compared with almost normal hip flexion, the risk of THA with degrees of the severely restricted, obviously restricted, and slightly restricted levels of the hip joint are nearly 26, 6, and 4 times, respectively. It shows that the worse the flexion of the hip joint is, the more likely it is to receive a replacement. The worse the patient's flexion function, the more it affects daily life. The decline in quality of life is likely to contribute to the patient's decision for seeking THA treatment.

Comprehensive Index Prediction Model Performance

The area under the ROC curve shows that the patient's age, duration of disease, ARCO stage, and hip joint function at the time of consultation have good performance as independent predictors. The composite predictive index obtained by the regression model of the above indicators is also effective for prediction of if the patient should receive

THA treatment. In summary, the treatment decision of THA in patients with ONFH is affected by many factors, mainly related to age, duration of disease, ARCO stage, and hip flexion function. The composite predictive model of the above factors can better guide clinical replacement; in addition, the indicators included in the predictive model are clinically common, easy to evaluate, and quick to apply, so can quickly make corresponding references to treatment decisions. In clinical practice, treatment recommendations for ONFH patients should be considered comprehensively.

Strengths and Limitations

The study focused on the topic of factors that influence the decision-making for THA in patients with ONFH through univariate analysis and binomial logistic regression, and composite index was established to predict if the patients would accept THA by integrating age, duration of disease, ARCO stage, and hip flexion. It has certain reference value for clinical practice.

This study also has a few limitations, including the nature of study, i.e., as a retrospective study, the factors discussed above cannot include all potential factors that may affect treatment decisions, such as economic status, the patient's own acceptance of surgery, and the status of physical complications. Therefore, it is expected that in the longitudinal follow-up research, we shall increase the sample size and conduct in-depth research and discussion.

Conclusions

Each of the above four indicators such as the age at the time of consultation, the duration of disease, the ARCO stage, and the hip joint flexion has guiding significance on whether ONFH patients need THA treatment. The comprehensive prediction model of the four indicators has good predictive ability on whether ONFH patients need THA treatment. Moreover, the evaluation method is simple, and the clinical application is convenient and quick. It has important clinical value for the correct selection of THA and hip preservation treatment cases in the clinic, and it is worthy of popularization and application.

Author Contributions

Prof. Weiheng Chen, and Dr. Rongtian Wang designed the project, edited the manuscript, and supervised the study. Prof. Ling Qin provided valuable comments for study design and data analysis, and edited the manuscript. Dr. Wei Wei, Dr. Biao Tan, and Dr. Yan Yan collected and analyzed data, and drafted the manuscript. Wenlong Li and Xiangrong Zeng, Qianglong Chen, Taixian Li, and Haijun He performed the statistical analysis and interpreted data. All listed authors have each made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; participated in drafting the manuscript or revising it critically for content; and have approved the final version of the submitted manuscript.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

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