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A comparative study on the clinical effectiveness of core decompression with bone grafting for treating alcohol-induced and traumatic osteonecrosis of the femoral head: a population-specific investigation in alcoholism.

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Keywords: core decompression; bone grafting; traumatic osteonecrosis of the femoral head; alcoholic-induced osteonecrosis of the femoral head.

Abstract. Osteonecrosis of the femoral head (ONFH) is a debilitating orthopedic condition with two primary categories: traumatic osteonecrosis (TONFH) and non-traumatic ONFH, including alcoholic-induced osteonecrosis (AIONFH). Core decompression combined with bone grafting is a common treatment approach, but its efficacy and influencing factors in these two categories remain unclear. We conducted a study involving 50 patients (25 TONFH, 25 AIONFH) who underwent this procedure. Demographic data and clinical assessments were collected. The average age was 47.2 years, with 72% males. AIONFH patients had a higher BMI and more comorbidities like diabetes, hyperlipidemia, hypertension, and immune-related diseases. TONFH had a higher prevalence of osteoporosis and fracture history. Bilateral hip necrosis was more frequent in TONFH, while left hip necrosis dominated in AIONFH. Both groups mainly had JIC classifications C1 and C2. Preoperatively, most cases were ARCO grade III and IV, with lower Harris, PCS, and MCS scores. Both groups improved at the six-month postoperative assessment, with better results in AIONFH. The last follow-up was 16.62 months after treatment. In the final follow-up, AIONFH cases were mainly ARCO type I, and HHS, PCS, and MCS scores were significantly better than TONFH. Core decompression combined with bone grafting effectively treats AIONFH and TONFH, with superior outcomes in AIONFH. Factors influencing postoperative efficacy include BMI, JIC classification, and PCS score. These findings provide valuable insights for tailoring treatment strategies to specific ONFH categories.

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Análisis comparativo de la eficacia clínica de la descompresión central combinada con injerto óseo en el tratamiento de la osteonecrosis traumática o inducida por alcohol de la cabeza femoral.

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Palabras clave: descompresión central; injerto óseo; osteonecrosis traumática de la cabeza femoral; osteonecrosis inducida por alcohol de la cabeza femoral.

Resumen. La osteonecrosis de la cabeza femoral (ONFH) es una afección ortopédica clasificada en dos categorías principales: osteonecrosis traumática (TONFH) y osteonecrosis no traumática, incluida la osteonecrosis inducida por alcohol (AIONFH). Un estudio con 50 pacientes (25 AIONFH, 25 TONFH) sometidos a descompresión central con injerto óseo evaluó su eficacia y factores influyentes. La edad promedio fue de 47,2 años, con un 72% de hombres y el seguimiento promedio fue de 16,62 meses. Los pacientes con AIONFH tenían un IMC más alto y más comorbilidades como diabetes, hiperlipidemia, hipertensión y enfermedades inmunológicas. La TONFH tenía una mayor prevalencia de osteoporosis y antecedentes de fracturas. La necrosis bilateral de cadera fue más frecuente en la TONFH, mientras que la necrosis de cadera izquierda dominaba en la AIONFH. Ambos grupos tenían principalmente clasificaciones JIC C1 y C2. Preoperatoriamente, la mayoría de los casos eran de grado ARCO III y IV, con puntajes de Harris, PCS y MCS más bajos. A los 6 meses de la evaluación posoperatoria, ambos grupos mejoraron, con resultados superiores en la AIONFH. El seguimiento promedio fue de 16,62 meses. En la última evaluación de seguimiento, la mayoría de los casos de AIONFH eran del tipo ARCO I, y los puntajes de HHS, PCS y MCS fueron significativamente mejores que en la TONFH. La descompresión central con injerto óseo trata eficazmente ambas categorías de ONFH, con resultados superiores en la AIONFH. Los factores que influyen en la eficacia posoperatoria incluyen el IMC, la clasificación JIC y el puntaje PCS. Estos hallazgos informan sobre la adaptación de las estrategias de tratamiento a las categorías de ONFH.

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INTRODUCCIÓN

Osteonecrosis of the femoral head (ONFH), or aseptic or avascular necrosis of the femoral head, is a progressive and painful orthopedic disease [1,2]. It can be categorized into traumatic and non-traumatic osteonecrosis based on its etiology. Non-traumatic ONFH is associated with various factors, including alcohol consumption, glucocorticoid use, infection, bone marrow infiltrative diseases, blood coagulation disorders, and certain autoimmune diseases [3]. According to a cross-sectional epidemiological study on ONFH in China, alcohol, steroids, and trauma are the three most common causes, with alcohol-induced non-traumatic osteonecrosis accounting for 37.15% and trauma-induced osteonecrosis accounting for 15.73%[4]. Regardless of the cause, without timely and effective treatment, the disease can lead to excruciating pain, the collapse of the femoral head, and impaired hip joint movement, significantly affecting the patient's quality of life [5].

Currently, clinical treatments for ONFH primarily focus on preserving hip joint function and halting disease progression. Various treatment modalities exist, including total hip arthroplasty, core decompression, vascularized and non-vascularized bone transplantation, and different osteotomy procedures [6]. Each treatment approach presents its advantages and drawbacks. Among these options, core decompression stands out as an ideal method, particularly for patients with early-stage ONFH [7]. This technique entails the removal of necrotic tissue from the femoral head, thereby reducing intraosseous pressure, promoting vascular reconstruction, facilitating bone regeneration within the necrotic region, relieving bone edema, and improving blood supply to the femoral head to foster lesion repair [8-10].

However, it should be noted that both thick channel core decompression and fine needle multi-hole drilling decompression procedures may inadvertently compromise the mechanical properties of the already fragile subchondral bone during the operation. Consequently, this may accelerate the collapse of the load-bearing surface of the femoral head or lead to subchondral bone fractures [11,12]. Combining core decompression with bone grafting has emerged as a viable solution to address this issue. Incorporating bone grafts into the necrotic segment after decompression provides structural support, facilitating subchondral bone reconstruction in the femoral head and mitigating the risk of cartilage collapse [13]. It is essential to recognize that the etiology of ONFH may vary, potentially impacting the clinical efficacy of core decompression combined with bone grafting. Thus, this study aims to analyze patients with alcohol-related ONFH (AIONFH) and traumatic ONFH (TONFH) to compare the clinical outcomes of core decompression combined with bone grafting in both types of patients and identify relevant factors. This research offers valuable insights to enhance the accuracy of the clinical application of core decompression and bone grafting for patients with ONFH.

MATERIAL AND METHODS

Subject Recruitment and Surgical Procedure

For this study, 50 patients were recruited based on strict inclusion and exclusion criteria. Twenty-five patients (35 hips) with TONFH were randomly selected to form the TONFH group, while another 25 patients (34 hips) diagnosed with AIONFH were chosen to constitute the AIONFH group.

All recruited patients underwent surgery under general anesthesia, assuming a supine position. The iliac crest served as the designated operation site. Prior to surgery, routine disinfection and towel laying were performed. The surgical procedure commenced with a layered tissue incision to expose the iliac crest. Subsequently, the iliac bone was removed using a bone knife, crushed with rongeurs, and rinsed with normal saline. Following this, a guide needle was used to puncture the necrotic site along the vertex of the greater trochanter of the femur, approximately 2 cm in length. Necrotic tissue was carefully scraped off from the site. Bone grafting material, composed of a mixture of the just removed bone tissue and artificial bone, was then crushed and implanted into the necrotic area, ensuring complete filling. Attention was given to confirm adequate filling of the bone graft, and any remaining bone tissue was placed into the channel. The wound was finally rinsed and sutured. Postoperatively, all patients were required to remain in bed for one month, after which they resumed limited activity combined with appropriate functional exercise. From three months post-surgery to six months post-surgery, patients utilized walking aids to increase weight-bearing exercise gradually. Whole weight-bearing exercise was used after six months post-surgery.

Inclusion criteria

1. Patients with a confirmed diagnosis of ONFH through imaging and clinical examinations. 2. Patients with ONFH caused either by alcohol consumption or traumatic incidents. 3. Patients who underwent core decompression combined with bone grafting as a treatment modality. 4. Patients who provided informed consent after being informed about the study.

Exclusion criteria

1. Patients with ONFH caused by hormonal imbalances or inflammation. 2. Patients who underwent treatment methods unrelated to core decompression combined with bone grafting. 3. Patients with an insufficient matching degree or lacking relevant case data. 4. Patients with severe conditions such as malignant tumors or hemorrhagic diseases.

Main observation index

This study utilized the hospital medical record system to gather crucial patient information, medical records during hospitalization, preoperative and postoperative imaging data, postoperative adverse reactions, and follow-up records. The primary data of patients, including sex, age, height, weight, body mass index (BMI), and complications, were collected. All patients underwent an impact examination upon admission, and regular follow-ups were conducted after the operation to assess the presence of necrosis and collapse of the femoral head. The classification system used for ONFH was based on the Japanese Investigation Committee, JIC classification.

The clinical efficacy was evaluated through the Association Research Circulation Osseous (ARCO) classification, Harris Hips score (HHS), and SF-36 scale before the operation and the follow-up at six months after and at the last follow-up.

The ARCO classification served as a means to categorize ONFH, providing insight into the surgical effect and enabling targeted adjustments to the treatment plan. In this study, the ARCO 2019 staging method was employed [14], dividing patients into four stages (I, II, III and IV) based on imaging examination results and pathological changes in the femoral head. Stage I showed abnormalities in X-ray examination, while MRI indicated a banded low signal surrounding the necrotic area. Stage IV was characterized by evident osteoarthritis, with an X-ray examination revealing bone-joint space narrowing, acetabular changes, and joint destruction.

HHS was utilized to evaluate the hip joint function, encompassing four aspects: pain degree (44 points), joint function (47 points), deformity (4 points), and range of motion (5 points). A higher score indicated better hip joint function, with scores less than 70 points indicating poor function, scores between 70 and 79 indicating medium-level function, scores between 80 and 89 indicating good function, and scores of 90-100 indicating excellent function.

The SF-36 scale was employed to assess patients' quality of life, covering eight aspects: physiological function, emotional function, physical pain, general health status, experience, social function, and mental health. The SF-36 conversion equation of the Chinese population published by Lam et al. was used to convert the questionnaire responses into physical health score (PCS) and mental health score (MCS), with higher scores indicating a better quality of life.

Additionally, the therapeutic effect was evaluated based on the results of the last follow-up, with patients without data at the last follow-up being analyzed using data from 6 months after the operation. The effectiveness of treatment was categorized as follows: "Extremely effective", indicating increased bone mineral density in the focus, with the cystic light transmission area and fissure sign returning to normal, and no collapse of the femoral head; "Effective", indicating increased bone mineral density in the focus, with the cystic light transmission area and fissure sign decreased, and femoral head collapse < 2mm; and "Ineffective," indicating femoral head collapse ≥ 2mm. The effective rate of treatment was calculated by summing the number of patients classified as "Extremely effective" and "Effective".

Statistical analysis

Data entry and collation of the questionnaire were performed using Excel software, while statistical data analysis was conducted using Statistic Package for Social Science (SPSS) 25.0 ® (IBM, Armonk, NY, USA). Continuous variables and classified variables in the study were described and analyzed in the form of "average ± standard deviation" and "cases (proportion)," respectively. For continuous variables conforming to the normal distribution, the independent sample T-test was employed to analyze differences between groups, while those not conforming to the normal distribution were analyzed using the Mann-Whitney U test. The classified variables were subjected to statistical analysis using the chi-square test or Fisher exact test. Univariate Logistic regression analysis was used to identify risk factors affecting treatment efficacy, while multivariate logistic regression analysis was employed to analyze significant indicators. Statistical results with $p<0.05$ were considered to have a significant difference in the data.

RESULTS

Study Characteristics

This study presents the patients' basic information and clinical characteristics, as outlined in Table 1. The average age of the patients included in the study was 47.2 ± 7.4 years, with a majority of male patients (72.0%). The BMI of the patients in the AIONFH group was significantly higher than that of the patients in the TONFH group ($p<0.05$). The prevalence of diabetes, hyperlipidemia, hypertension, and immune-related diseases was higher in the AIONFH group compared to the TONFH group, while the history of osteoporosis and fracture was more frequent in the TONFH group. Regarding postoperative adverse reactions, both groups experienced a higher occurrence of severe pain and deep venous thrombosis at the last follow-up, and there was no significant difference between the two groups ($p >0.05$).

Imaging Features

The imaging results for both groups are detailed in Table 1. Among the patients in the TONFH group, 40.00% exhibited necrosis in both hip joints, while in the AIONFH group, 40.00% displayed necrosis in the left hip joint. According to the JIC classification, many patients in both groups were categorized as C1 and C2 types. Specifically, the TONFH group had a higher proportion of C2 type (45.71%) compared to C1 type (34.29%), whereas both C1 and C2 types were equally distributed in the AIONFH group (38.24%). No significant difference between the two groups was observed in hip joint pathological changes and JIC classification.

Comparison of ARCO classification, HHS and SF-36 score between the two groups before operation

Results of ARCO classification, HHS, and SF-36 score for both groups before the operation are presented in Table 2. No significant difference was found in the above indexes between the two groups before the operation ($p>0.05$). The most common ARCO classification in both groups was Grade IV. In terms of Harris score, the scores for both groups were significantly lower than 70, indicating poor hip joint function.

Table 1
Basic information and clinical characteristics of patients.

Variables		Total	TONFH Group	AIONFH Group	$t/Z/\chi^2/F$	*p*
Patients/hips		50/69	25/35	25/34		
Age (year, mean ± SD)		47.2±7.4	45.6±8.2	48.8±6.2	1.528	0.133
Gender n (%)	Male	36 (72)	16 (64)	20(80)	1.587	0.208
	Female	14 (28)	9 (36)	5(20)		
BMI (kg/m^2, mean ± SD)		23.81±2.49	22.85±2.54	24.78±2.06	2.949	0.005
Smoking n (%)		27(54)	13(52)	14(56)	0.081	0.777
Alcohol n (%)		40(80)	15(60)	25(100)	12.500	<0.001
Pathogeny n (%)	Alcohol	25(50)	-	25(100)	-	-
	Trauma	21(42)	21(84)	-		
	Others	4(8)	4(16)	-		
Complications / existing medical history n (%)	Diabetes	23(46)	9(36)	14(56)	22.543	<0.001
	Hyperlipidemia	27(54)	9(36)	18(72)		
	Hypertension	28(56)	10(40)	16(64)		
	Immune-related diseases	19(38)	7(28)	12(48)		
	Osteoporosis	26(52)	14(56)	12(48)		
	Fracture	23(46)	21(84)	2(8)		
Necrotic hip joint n (%)	Left	18(26.09)	8(32)	10(40)	0.352	0.839
	Right	13(18.84)	7(28)	6(24)		
	Both	19(27.54)	10(40)	9(36)		
JIC classification n (%)	A	7(10.14)	4(11.43)	3(8.82)	0.985	0.805
	B	8(11.59)	3(8.57)	5(14.71)		
	C1	25(36.23)	12(34.29)	13(38.24)		
	C2	29(42.03)	16(45.71)	13(38.24)		
Postoperative adverse reactions n (%)	Severe pain	8(16)	4(16)	4(16)	0.287	0.963
	Infected	2(4)	1(4)	1(4)		
	Deep venous thrombosis	6(12)	3(12)	3(12)		
	Hematoma	3(6)	1(4)	2(8)		
Follow-up time (month, mean ± SD)		16.62±5.21	17.04±5.22	16.2±5.28	0.566	0.574

$p<0.05$ indicates statistical significance.

For continuous variables conforming to the normal distribution, the independent sample T-test was employed to analyze differences between groups, while those not conforming to the normal distribution were analyzed using the Mann-Whitney U test. The classified variables were subjected to statistical analysis using the chi-square test or Fisher exact test; Traumatic osteonecrosis (TONFH); non-traumatic- alcoholic-induced osteonecrosis (AIONFH). BMI: body mass index; JIC: Japanese Investigation Committee Classification.

Table 2
Comparison of ARCO classification, HHS and SF-36 score between the two groups before operation.

Variables		TONFH Group	AIONFH Group	$t/Z/\chi^2$	p
Patients/hips		25/35	25/34		
ARCO n (%)	I/II	3 (8.57)	3 (8.82)	0.825	0.662
	III	8 (22.86)	11(32.35)		
	IV	24 (68.57)	20 (58.82)		
HHS (score, mean ± SD)	Pain	21.4±2.72	21.09±3.18	0.691	0.490
	Function	23.31±3.34	23.65±2.59	0.461	0.646
	Deformity	4±0	4±0	-	-
	Range of motion	0.6±0.65	0.59±0.5	0.190	0.849
	Total scores	49.31±5.11	49.32±5.76	0.007	0.994
SF-36 (score, mean ± SD)	PCS	32.64±2.89	32.04±2.73	0.755	0.454
	MCS	43.48±1.85	43.04±3.52	0.553	0.583

$p<0.05$ indicates statistical significance.

For continuous variables conforming to the normal distribution, the independent sample T-test was employed to analyze differences between groups, while those not conforming to the normal distribution were analyzed using the Mann-Whitney U test. The classified variables were subjected to statistical analysis using the chi-square test or Fisher exact test.

Traumatic osteonecrosis (TONFH) ; non-traumatic-alcoholic-induced osteonecrosis (AIONFH). ARCO: Association Research Circulation Osseous; HHS: Harris Hip Score; SF-36: 36-Item Short Form Health Survey.

Comparison of ARCO classification, HHS and SF-36 score between the two groups of the follow-up at 6 months after operation

Six months after the operation, the results of ARCO classification, HHS, and SF-36 score for both groups are shown in Table 3. However, it is worth noting that one patient in the TONFH group could not be reached for follow-up, reducing the number of patients/hips to 24/34 in this group.

In terms of ARCO typing, a majority of patients in the AIONFH group were classified as type III (61.76%), while those in the TONFH group still belonged to grade IV (38.24%). This difference between the two groups was statistically significant ($p < 0.05$). The total HHS for the AIONFH group was (73.24 ± 8.45), indicating a significant improvement in hip joint function for these patients. On the other hand, the Harris score for the TONFH group remained lower than 70 ($p<0.05$), indicating persistent poor hip joint function. Moreover, the scores of PCS and MCS in the AIONFH group were higher compared to those in the TONFH group, and the difference in MCS scores was found to be significant. This suggests that patients with AIONFH experienced better physical and mental health outcomes compared to those with TONFH.

Comparison of ARCO classification, HHS and SF-36 score between the two groups at the last follow-up

At the last follow-up, the results of ARCO classification, Harris score, and SF-36 score for both groups are presented in Table 4. It should be noted that during the last follow-up, two patients in the TONFH group and four patients in the AIONFH group could not be contacted normally, reducing the number of patients/hip joints to 22/31 and 21/29.

At the last follow-up, significant differences were observed in the results of all three indexes between the AIONFH and TONFH

Table 3
Comparison of ARCO classification, HHS and SF-36 score between the two groups 6 months after operation.

Variables		TONFH Group	AIONFH Group	*t/Z /χ2*	*p*
Patients/Hips		24/34	25/34		
ARCO n (%)	I	1(2.94)	5(14.71)	15.156	0.002
	II	11(32.35)	5(14.71)		
	III	9(26.47)	21(61.76)		
	IV	13(38.24)	4(11.76)		
HHS (score, mean ± SD)	Pain	25.59±2.73	32.85±3.81	5.881	<0.001
	Function	27.76±3.96	34.76±4.63	6.701	<0.001
	Deformity	4±0	4±0	-	-
	Range of motion	1.26±0.45	1.62±0.92	1.416	0.157
	Total scores	61.62±5.83	73.24±8.45	6.600	<0.001
SF-36 (score, mean ± SD)	PCS	36.21±4.49	38.08±4.73	1.529	0.126
	MCS	45.25±2.77	47.52±4.82	2.030	0.049

$p<0.05$ indicates statistical significance.

For continuous variables conforming to the normal distribution, the independent sample T-test was employed to analyze differences between groups, while those not conforming to the normal distribution were analyzed using the Mann-Whitney U test. The classified variables were subjected to statistical analysis using the chi-square test or Fisher exact test.

Traumatic osteonecrosis (TONFH); non-traumatic- alcoholic-induced osteonecrosis (AIONFH). ARCO: Association Research Circulation Osseous; HHS: Harris Hip Score; SF-36: 36-Item Short Form Health Survey.

groups ($p<0.05$). In the AIONFH group, most patients were classified as type I according to the ARCO classification (43.33%), while most patients in the TONFH group were classified as type II (38.71%). This difference in ARCO classification between the two groups was statistically significant. The HHS of patients in both groups were higher than 70, indicating improved hip joint function. However, the Harris scores in the AIONFH group were notably higher than 80. Furthermore, the scores of PCS and MCS in the AIONFH group were significantly higher than those in the TONFH group.

Therapeutic effect of two groups of patients

The therapeutic effects of the two groups are shown in Table 5. The total effective rate of the AIONFH group was 76.47%, which was higher than that of TONFH group (55.88%).

Analysis of the related factors affecting the prognosis of patients

Table 6 presents the results of the Logistic regression analysis conducted to identify possible factors related to the prognosis of patients. The univariate Logistic analysis examined several factors, including BMI, immune-related diseases, history of osteoporosis, JIC classification, HHS, PCS, and MCS. The analysis revealed that these factors showed statistical significance concerning the prognosis of patients.

Upon further analysis using multivariate Logistic regression, three factors were statistically significant predictors of prognosis. These factors were BMI, JIC classification, and PCS.

Table 4
Comparison of ARCO/ classification, HHS and SF-36 score between the two groups at six months after the last follow-up.

Variables		TONFH Group	AIONFH Group	Z/χ^2	*p*
Patients/Hips		22/31	21/29		
ARCO▲ n (%)	I	3(9.68)	13(43.33)	10.806	0.013
	II	12(38.71)	10(33.33)		
	III	5(16.13)	3(10)		
	IV	11(35.48)	4 (13.33)		
HHS▲ (score, mean ± SD)	Pain	32.58±5.1	36.83±6.29	3.225	0.001
	Function	35.39±7.28	40.00±6.26	3.100	0.002
	Deformity	3.77±0.43	3.86±0.35	0.872	0.383
	Range of motion	3.13±1.71	3.59±1.4	0.713	0.476
	Total scores	74.87±14.17	84.28±13.99	2.791	0.005
SF-36▲ (score, mean ± SD)	PCS	41.86±8.35	45.86±7.32	2.296	0.022
	MCS	47.26±3.78	50.27±5.48	2.088	0.037

▲ The results were compared with the corresponding indexes of this group before operation, $p < 0.05$; $p<0.05$.

For continuous variables conforming to the normal distribution, the independent sample T-test was employed to analyze differences between groups, while those not conforming to the normal distribution were analyzed using the Mann-Whitney U test. The classified variables were subjected to statistical analysis using the chi-square test or Fisher exact test.

Traumatic osteonecrosis (TONFH); non-traumatic- alcoholic-induced osteonecrosis (AIONFH). ARCO: Association Research Circulation Osseous; HHS: Harris Hip Score; SF-36: 36-Item Short Form Health Survey.

Table 5
Clinical treatment of patients in two groups.

Groups	Extremely effective	Effective	Ineffective	Total efficiency
TONFH Group (34 hips)	15(44.12)*	4(11.76)	15 (44.12)	19 (55.88)
AIONFH Group (34 hips)	23(67.65)	3(8.82)	8 (23.53)	26 (76.47)
χ^2 *value*				3.219
p value				0.073

* n (%).

$p<0.05$ indicates statistical significance.

Traumatic osteonecrosis (TONFH); non-traumatic- alcoholic-induced osteonecrosis (AIONFH).
The classified variables were subjected to statistical analysis using the chi-square test or Fisher exact test.

DISCUSSION

Core decompression combined with bone grafting is ideal for treating AIONFH and TONFH

ONFH is a challenging orthopedic condition with a high disability rate, necessitating timely and effective treatment to preserve patients' health and quality of life [15]. Among various treatment approaches, core decompression and bone grafting are considered favorable surgical methods [16]. The combination of these techniques not only reduces internal pressure in the femoral head, alleviates bone marrow edema, and enhances intraosseous microcirculation through

Table 6
Logistic regression analysis of factors related to prognosis of patients.

Predictor	Univariables OR (95% CI)	*p*	Multivariables OR (95% CI)	*p*
Pathogeny	2.566(0.905-7.275)	0.076		
Gender	0.653(0.21-2.027)	0.461		
Age	0.979(0.906-1.059)	0.602		
BMI	0.723(0.571-0.915)	0.007	0.692(0.507-0.944)	0.020*
Smoking	2.141(0.771-5.945)	0.144		
Alcohol	0.389(0.128-1.181)	0.096		
Diabetes	2.612(0.902-7.569)	0.077		
Hyperlipidemia	1.146(0.418-3.138)	0.791		
Hypertension	1.95(0.705-5.394)	0.198		
Immune-related diseases	0.28(0.097-0.805)	0.018	0.133(0.007-2.47)	0.176
Osteoporosis	0.222(0.07-0.703)	0.011	3.365(0.536-21.125)	0.195
Fracture	0.429(0.153-1.198)	0.106		
JIC	5.526(1.726-17.692)	0.004	14.275(1.117-182.387)	0.041*
HHS	0.811(0.707-0.93)	0.003	0.779(0.594-1.023)	0.072
PCS	0.581(0.432-0.78)	<0.001	0.419(0.192-0.913)	0.029*
MCS	0.674(0.52-0.875)	0.003	0.781(0.475-1.284)	0.330

*p<0.05.

Univariate Logistic regression analysis was used to identify risk factors affecting treatment efficacy, while multivariate Logistic regression analysis was employed to analyze significant indicators.

Body mass index (BMI); JIC: Japanese Investigation Committee; HHS: Harris Hip Score; Physical Health Score (PCS); Mental Health Score (MCS).

improved muscle and pulse reflux but also facilitates osteogenesis, bone repair, and provides structural support to the femoral head, thereby reducing the risk of postoperative femoral head collapse [17].

Prior research by Larson et al. indicated that using core decompression alone to treat ONFH yields variable clinical success rates, with the lowest rate being only 20%, leading to uncertain therapeutic outcomes [18]. However, our study demonstrates that combining core decompression with bone grafting yields better therapeutic results for patients with AIONFH and TONFH, achieving 55.88% and 76.47% success rates. By comparing various indices before surgery, at six months after the operation, and at the last follow-up, we observed an improvement in the ARCO classification from grade III/IV to grade I/II in both groups. The HHS and SF-36 scores were also significantly enhanced, indicating notable improvements in hip joint function and overall quality of life. The ARCO classification system is widely used to assess ONFH and reflects the occurrence of femoral head collapse [5,19]. The HHS provides a comprehensive evaluation of post-surgery hip joint function. The combination of these assessments effectively captures the hip joint's recovery and the overall well-being of the patients [20]. The SF-36 scale is a reliable tool for measuring health-related quality of life [21], and when combined with the other measures, it highlights the substantial positive impact of the surgical intervention on the patient's functional recovery and psychological well-being.

Core decompression combined with bone grafting has a better therapeutic effect on AIONFH

Upon further analysis, we observed that the therapeutic efficacy of core decompression combined with bone grafting was superior in patients with AIONFH compared to those with TONFH. TONFH is generally caused by direct trauma to the femoral head, leading to the disruption of blood supply, ischemia, and hypoxia of osteocytes, ultimately resulting in necrosis [22]. The blood supply to the femoral head is primarily from the medial and lateral circumflex femoral arteries, which supply blood to the lateral anterior superior region and the area below the femoral head. Fractures, particularly in the femoral neck region, can damage these arteries, increasing the likelihood of ONFH.

On the other hand, AIONFH arises mainly from an imbalance in osteogenesis/osteoclast activity and abnormal lipid metabolism, causing ischemia, hypoxia, venous stasis, and elevated intraosseous pressure in the femoral head [23,24]. Considering the unique characteristics of core decompression combined with bone grafting and the distinct pathological nature of the two diseases, this treatment approach holds greater promise for managing AIONFH. Our study supports this notion, as the total effective rate in the AIONFH group was higher than that in the TONFH group. Moreover, starting from six months after the operation, many indices in the AIONFH group showed better outcomes than those in the TONFH group. At the last follow-up, except for “deformity” and “range of motion” in the Harris score, all other indices demonstrated significant improvement in the AIONFH group compared to the TONFH group. These findings suggest that core decompression combined with bone grafting yields superior clinical efficacy in treating AIONFH, leading to more pronounced improvements in the patients’ quality of life.

Overall, the results indicate that the chosen treatment approach is more advantageous for AIONFH patients due to its ability to address the disease’s specific pathological mechanisms. This study highlights the importance of selecting appropriate treatment strategies tailored to the unique characteristics of different types of femoral head necrosis, ultimately leading to better clinical outcomes and improved patient well-being.

BMI, JIC classification and PCS score are the risk factors affecting the prognosis of patients

Our results also indicated that BMI, JIC classification, and PCS score could be potential risk factors influencing the prognosis of patients with AIONFH and TONFH. BMI is a commonly used indicator to assess body weight and is employed to evaluate various health conditions [25], including obesity and the risk of fractures [26], hypertension [27], and kidney disease [28]. Prior studies have highlighted the crucial role of lipid metabolism in the development of femoral head osteonecrosis. Lowering body fat content has been shown to enhance osteogenesis, while lipid metabolism disorders may lead to fat entering the bloodstream and spreading throughout the body, potentially affecting bone marrow and increasing intramedullary pressure. This process could obstruct venous reflux and impede blood circulation within bone tissue, ultimately influencing the clinical effectiveness of intramedullary decompression combined with bone grafting. Hence, higher BMI levels may impact the treatment outcomes of this surgical approach.

Additionally, the location of the necrotic area within the femoral head is closely associated with femoral head collapse and pain [29,30]. When the osteonecrosis area is located inside the weight-bearing region, the subchondral bone remains more intact, enhancing femoral head stability and reducing pain and collapse rates during weight-bearing [31,32]. On the contrary, when the JIC classification of the patient indicates type C, where the necrotic area is situated outside the weight-bearing region, patients tend to experience more severe pain, and the probability of postoperative femoral head collapse is higher. Therefore, the JIC classification serves as an effective index for predicting the prognosis of patients.

Furthermore, the PCS score reflects patients' physical health and indirectly indicates the impact of femoral head osteonecrosis on their life. Patients' quality of life is often closely related to the severity and duration of the disease and the stress caused by it [33]. As a result, the PCS score can provide insights into the patient's overall condition and prognosis, helping to gauge the severity of the disease and its impact on the patient's well-being.

Considering BMI, JIC classification, and PCS score as potential risk factors in the prognosis of AIONFH and TONFH patients can aid in understanding their clinical outcomes and developing appropriate treatment strategies tailored to their specific conditions. The findings of this study underscore the efficacy of core decompression combined with bone grafting in treating avascular necrosis of the femoral head (ONFH), particularly in the context of alcohol-induced ONFH. While the results of this study support the positive outcomes of this surgical technique, it is essential to acknowledge that the focus on alcohol-induced ONFH necessitates specific consideration of the population studied. Given the epidemiological significance of alcohol-induced ONFH in specific populations, it is crucial to emphasize the specificity of this study's findings to the alcoholism-related etiology in the title of the manuscript. By recognizing the unique epidemiological aspects of the study population, the results and implications can be more accurately contextualized and better aligned with the specific medical-metabolic origins of alcohol-induced ONFH.

While the current study included assessments at preoperative, six months postoperative, and a final follow-up, we acknowledge the need for more frequent and intermediate medical controls during the postoperative period. Therefore, it is recommended to incorporate interim assessments at specific intervals, such as three months and 12 months postoperatively, to provide a more comprehensive understanding of the progression and outcomes of the surgical treatment. These additional checkpoints will allow for a more nuanced evaluation of the patient's recovery and the effectiveness of the intervention, particularly in the context of the described surgical treatment approach for osteonecrosis of the femoral head. Further, it is imperative to acknowledge the significance of utilizing additional assessment scales, including imaging-based evaluations, alongside standard clinical rating scales for a comprehensive evaluation of treatment outcomes in osteonecrosis of the femoral head. While the study incorporated reliable and internationally recognized clinical rating scales such as the Association Research Circulation Osseous (ARCO) classification, Harris Hip Score (HHS), and SF-36 scale, the inclusion of imaging-based assessments, such as MRI and X-ray evaluations, would provide valuable insights into the structural changes and healing progression within the femoral head post-surgery. The integration of imaging assessments will offer a more holistic understanding of the treatment response and aid in determining the success of the surgical intervention from both functional and anatomical perspectives. Therefore, it is recommended to consider including imaging-based evaluation tools as supplementary measures to augment the comprehensive assessment of treatment outcomes in future research endeavors. Besides, this study included its focus on a specific population and etiological factors, which may restrict the generalizability of the findings to other populations and ONFH etiologies.

In conclusion, core decompression combined with bone grafting has demonstrated promising therapeutic outcomes for AIONFH and TONFH, with particularly significant results observed in AIONFH cases.

This treatment approach improves hip joint function and effectively enhances patients' overall quality of life while mitigating the risk of postoperative femoral head collapse. Consequently, it is a recommended surgical method for managing these conditions.

Moreover, our findings suggest that BMI, JIC classification, and PCS score may serve as potential risk factors influencing the prognosis of patients with AIONFH and TONFH. Patients who present with specific indicators related to these factors should receive heightened attention and suitable treatment measures to improve the surgery's clinical effectiveness and prognostic outcomes. Furthermore, as medical advancements continue to progress, the availability of various bone grafting options has expanded. Building upon the established efficacy of core decompression combined with bone grafting in treating AIONFH, further exploration into different types of bone grafts may offer additional opportunities for treatment optimization.

Conflict of interests

The authors declared no conflict of interest.

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