



Original Research

The Effect of Systemic Steroid Use on the Success of Core Decompression in Non-Traumatic Early-Stage Femoral Head Osteonecrosis

Gokhan Pehlivanoglu, Osman Cimen, Alper Koksak

Department of Orthopaedics and Traumatology, University of Health Sciences Baltalimani Bone Diseases Training and Research Hospital, Istanbul, Türkiye

Abstract

Objectives: Systemic corticosteroid use is a well-established risk factor for non-traumatic osteonecrosis of the femoral head (ONFH). However, its impact on the clinical outcomes of joint-preserving procedures, such as core decompression (CD), remains uncertain. This study aimed to evaluate whether systemic steroid exposure influences the success of CD in patients with early-stage ONFH.

Methods: This retrospective cohort study included 49 hips from 41 patients with Ficat stage IIa ONFH who underwent isolated CD between 2013 and 2021. Patients were stratified into two groups according to systemic corticosteroid use within one year prior to diagnosis. Demographic and radiologic data, including modified Kerboul angle and stage, were collected. Treatment success was defined as the absence of femoral head collapse or conversion to total hip arthroplasty at the final radiologic follow-up. Outcomes were compared between steroid users and non-users using t-tests, Mann-Whitney U, chi-square, and Fisher's exact tests, as appropriate.

Results: Overall, treatment success was achieved in 63.3% of hips. The success rate was 70.4% in steroid users and 54.5% in non-users, but this difference was not statistically significant ($p=0.372$). Baseline radiologic parameters, including modified Kerboul angle and stage, did not differ significantly. Sex distribution differed significantly ($p=0.003$), while age, follow-up duration, and bilaterality were comparable.

Conclusion: Systemic corticosteroid use was not significantly associated with worse radiologic outcomes following CD in early-stage ONFH. These findings support CD as a viable joint-preserving treatment in appropriately selected patients, irrespective of prior steroid exposure.

Keywords: Femoral head, glucocorticoids, osteonecrosis, surgical decompression, treatment outcome

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Osteonecrosis of the femoral head (ONFH) is a progressive, debilitating condition that primarily affects young and middle-aged individuals and can lead to femoral head collapse and early-onset osteoarthritis if untreated.^[1] Among the available treatment options for early-stage ONFH, core decompression (CD) is the most

widely performed surgical procedure. Its goal is to relieve intraosseous pressure, improve vascularity, and delay or prevent the need for total hip arthroplasty (THA).^[1-3] The outcomes of CD vary considerably and appear to be influenced by several factors, including lesion size, disease stage, and patient-related variables such as systemic corti-

Address for correspondence: Gokhan Pehlivanoglu, MD. Department of Orthopaedics and Traumatology, University of Health Sciences, Baltalimani Bone Diseases Training and Research Hospital, Istanbul, Türkiye

Phone: +90 505 364 21 85 **E-mail:** drgokhanpehlivanoglu@gmail.com

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corticosteroid exposure.^[4-8] Corticosteroid exposure is a well-established non-traumatic risk factor for ONFH, but its impact on surgical outcomes following CD remains uncertain.^[8-10] Some studies have suggested worse prognoses and higher rates of femoral head collapse in patients with steroid-associated ONFH, whereas others have reported comparable outcomes between patients with and without steroid exposure.^[11-13]

However, there is a paucity of literature specifically addressing the impact of corticosteroid exposure on postoperative outcomes after core decompression in patients with ONFH. This gap limits the current understanding of whether corticosteroid exposure represents a true prognostic disadvantage for bone healing and revascularization following CD.

Radiological assessment also plays a critical role in predicting prognosis. The modified Kerboul angle, which quantifies necrotic lesion size on magnetic resonance imaging (MRI), is frequently used to stratify collapse risk. Larger Kerboul angles have been consistently associated with higher failure rates in the treatment of ONFH.^[5-7]

This study aimed to evaluate the clinical outcomes of CD in patients with early-stage ONFH and to investigate whether systemic corticosteroid exposure adversely affects radiological prognosis.

Methods

This retrospective cohort study was conducted at the Baltalimani Bone Diseases Training and Research Hospital. Medical records of the patients who underwent CD for non-traumatic ONFH between January 2013 and December 2021 were reviewed.

A total of 51 patients who underwent CD for ONFH were initially screened. All cases were of non-traumatic origin; no patients with trauma-related osteonecrosis were present in the cohort. Of these, 11 cases (in 10 patients) were excluded due to prior hip surgery (n=1), Ficat stage I disease (n=1), incomplete clinical or imaging records (n=2), and the use of autografts (n=2), or biological agents such as demineralized bone matrix (DBM) (n=5). In one patient, both hips met the exclusion criteria. The final study population consisted of 41 patients (49 hips) who met all inclusion criteria and had a minimum postoperative follow-up of 12 months (Fig. 1).

Inclusion criteria were patients aged ≥ 18 years with unilateral or bilateral ONFH, Ficat stage IIa disease confirmed by preoperative radiographs, a minimum postoperative follow-up of 12 months, and available preoperative MRI.^[14] Exclusion criteria were prior surgical intervention on the affected hip, traumatic etiology, incomplete clinical or imaging records, or use of grafting materials, bone substitutes,

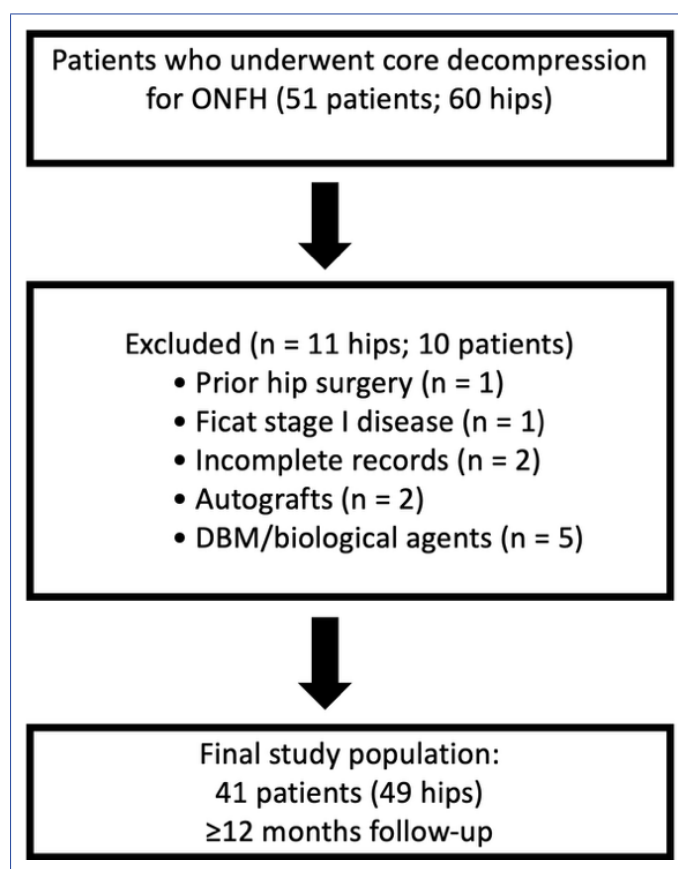


Figure 1. Flowchart summarizing patient selection and exclusion process.

or biological agents during decompression.

A total of 49 hips from 41 patients met the inclusion criteria. This study was approved by the Metin Sabanci Baltalimani Bone Diseases Training and Research Hospital Institutional Ethics Committee (Date: 04.07.2025, Decision no: 38-290). Written informed consent was obtained from all participants. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Demographic variables, including age, sex, systemic corticosteroid exposure history, laterality (bilateral or unilateral), and operated side, were recorded. Age was calculated at the time of surgery. Systemic corticosteroid exposure was defined as administration for more than two weeks within one year prior to ONFH diagnosis, reflecting chronic or cumulative exposure rather than a single or short-term high-dose course, consistent with previous reports linking osteonecrosis mainly to prolonged exposure.^[10,15] Preoperative lesion size was evaluated using the modified Kerboul angle measured on T1-weighted coronal and sagittal MR images, and staging was assigned according to the Kerboul classification (Stages I–IV).^[6,16] Treatment success was defined as the absence of femoral head collapse on the most recent radiographic evaluation. Failure was

defined as subchondral collapse or progression to THA. Patients were stratified into two groups based on systemic corticosteroid exposure: Group 1 included patients without exposure, and Group 2 included patients with exposure. Clinical and radiological outcomes were compared between the groups.

Surgical Technique

All CD procedures were performed under spinal or general anesthesia, with the patient in the supine position on a radiolucent or traction table. After standard aseptic preparation and antibiotic prophylaxis, a 2–3 cm lateral incision was made over the proximal femur, followed by blunt dissection to expose the lateral cortex.

Using biplanar fluoroscopy, a 3.2-mm guidewire was advanced toward the necrotic zone identified on MRI. Once the trajectory was confirmed, an 8-mm cannulated drill was used to decompress the necrotic area without breaching the subchondral bone. No grafts or biologic agents were used (non-augmented technique). The wound was closed in layers.

Postoperatively, patients followed a protected weight-bearing protocol with crutches for six weeks, progressing to full weight-bearing based on clinical and radiological recovery.

Statistical Analysis

A post-hoc power analysis was performed using G*Power 3.1 (test family: Exact; Fisher's exact test, two-tailed).

Based on the observed proportions of radiological success between the steroid non-exposed (0.545) and steroid-exposed (0.704) groups ($\alpha=0.05$; $n_1=22$; $n_2=27$), the achieved power ($1-\beta$) was 0.17.

Statistical analyses were performed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean \pm standard deviation, and categorical variables as frequencies with percentages. The Shapiro–Wilk test was used to assess the normality of distribution for continuous variables. Group comparisons were performed using the independent samples t-test for normally distributed variables and the Mann–Whitney U test for non-normally distributed variables. Categorical variables were compared using either the chi-square test or Fisher's exact test, as appropriate. Statistical significance was set at $p<0.05$.

Inter- and intraobserver reliability analyses for Kerboul angle measurements were performed using a two-way mixed-effects model with absolute agreement to calculate intraclass correlation coefficients (ICC). Reliability was interpreted according to the following thresholds: <0.5 , poor; $0.5-0.75$, moderate; $0.75-0.9$, good; and >0.9 , excellent.^[17]

Results

A total of 49 hips from 41 patients were included. All patients had Ficat stage IIa ONFH. Group 1 comprised 22 hips, and Group 2 included 27 hips. Age and follow-up duration were comparable between groups (Table 1). A significant sex difference was noted, with males predominating in Group 1 and a more balanced male-to-female ratio in Group 2 ($p=0.003$). No significant difference was found in the distribution of the operated side (Table 1).

Bilateral ONFH was observed in the majority of patients, and the distribution was similar between groups ($p=0.685$; Table 2). Among patients with bilateral ONFH, contralateral hips that were not treated with CD as part of this study underwent different surgical interventions depending on clinical presentation and disease severity. In Group 1, three contralateral hips were treated with vascularized fibular grafting, one with a trapdoor procedure using autograft, and one with THA. In Group 2, five contralateral hips received vascularized fibular grafting, and three underwent THA.

The mean modified Kerboul angle and distribution of Kerboul stages were similar between the groups ($p=0.480$ and $p=0.754$, respectively; Table 2).

At the final radiological follow-up, no significant difference in treatment success, defined as the absence of femoral head collapse, was observed between the groups ($p=0.372$; Table 2). Overall, femoral head preservation was achieved in 31 of 49 hips, corresponding to an overall success rate of 63.3%. THA was ultimately required in one patient from Group 1 and two patients from Group 2 due to progressive femoral head collapse with persistent symptoms.

Table 1. Comparison of demographic characteristics between groups

	Group 1 (non-exposed) (n=22)	Group 2 (systemic corticosteroid-exposed) (n=27)	p
Age (years)	36.7 \pm 9.5	34.4 \pm 7.7	0.314 ⁱ
Follow-up (months)	46.4 \pm 28.9	39.4 \pm 23.0	0.463 ^m
Sex (M/F)			0.003 ^f
Male	21 (95.5%)	15 (55.6%)	
Female	1 (4.5%)	12 (44.4%)	
Operated side			0.388 ^f
Right	8 (36.4%)	14 (51.9%)	
Left	14 (63.6%)	13 (48.1%)	

ⁱFisher's exact test, ⁱindependent samples t-test, ^mMann-Whitney U test, Data are presented as mean \pm standard deviation (SD) or count (percentage), as appropriate.

Table 2. Comparison of baseline radiologic parameters and treatment outcomes between groups

	Group 1 (non-exposed) (n=22)	Group 2 (systemic corticosteroid-exposed) (n=27)	p
Bilaterality*			0.685 ^f
Yes	15 (78.9%)	19 (86.4%)	
No	4 (21.1%)	3 (13.6%)	
Kerboul angle	262.7°±51.6	257.6°±63.4	0.480 ^t
Kerboul stage			0.754 ^x
Stage 1	2 (9.1%)	5 (18.5%)	
Stage 2	6 (27.3%)	5 (18.5%)	
Stage 3	7 (38.1%)	9 (33.3%)	
Stage 4	7 (38.1%)	8 (29.6%)	
Treatment outcome			0.372 ^f
Success	12 (54.5%)	19 (70.4%)	
Failure	10 (45.5%)	8 (29.6%)	

*Bilaterality counts refer to patients, not hips; ^fFisher's exact test, ^xchi-square test, ^tindependent samples t-test; Data are presented as mean ± standard deviation (SD) or count (percentage), as appropriate.

Interobserver reliability for Kerboul angle measurements on MRI was excellent, with an ICC of 0.981 (95% CI, 0.933–0.992; $p < 0.001$). Intraobserver reliability (same observer, repeated measurements after 15 days) was also excellent, with an ICC of 0.987 (95% CI, 0.974–0.993; $p < 0.001$). Both analyses were based on a two-way mixed-effects model with absolute agreement, indicating excellent measurement consistency.^[17]

Discussion

Core decompression is a well-established joint-preserving procedure for early-stage ONFH.^[18–20] Prior studies, including the systematic review by Mont et al.,^[1,21] have reported success rates of 65–84% for Ficat stages I–II lesions, depending on lesion size and disease extent.^[2,22,23] Stage IIa lesions, in particular, have shown favorable responses to CD without biological augmentation.^[21] Our overall success rate of 63.3% aligns with these findings, reinforcing the role of CD as a reliable option in carefully selected stage IIa patients.^[1,5]

Although corticosteroids are a major etiologic factor in non-traumatic ONFH development, their effect on surgical prognosis remains debated.^[8–10] In our study, treatment success was 70.4% in corticosteroid-exposed patients and 54.5% in non-exposed patients, although this difference did not reach statistical significance. This suggests that

prior corticosteroid exposure does not necessarily impair femoral head preservation when CD is performed at the appropriate disease stage.

Tsai et al.^[11] reported a nearly universal collapse rate (98.7%) in untreated steroid-associated ONFH patients over an average follow-up of 19.4 months. However, their population included symptomatic stage II–III cases. In contrast, Mont et al.^[13] observed a more indolent course in asymptomatic steroid-related ONFH, with a 26% collapse rate over 88 months. These differences highlight the importance of considering disease stage and symptomatology when evaluating prognosis. In our homogeneous stage IIa cohort, early surgical intervention appears to mitigate the risks associated with corticosteroid exposure.

Su et al.^[12] similarly identified corticosteroid use as a predictor of collapse after tantalum rod implantation, but their analysis included mixed disease stages and implant-related confounders. Our focused design eliminates these variables, providing clearer insight into the role of systemic corticosteroid exposure in isolated CD.

All patients in our cohort were at the same disease stage, and both groups demonstrated comparable lesion characteristics based on the modified Kerboul angle and disease stage. Additionally, all underwent a standardized, non-augmented decompression technique. This methodological consistency supports the internal validity of our comparative analysis and suggests that lesion size was not a confounding factor.

In our study, the male-to-female ratio was 15:12 in the corticosteroid-exposed group and 21:1 in the non-exposed group ($p = 0.003$), consistent with previous reports showing a male predominance in ONFH, although sex distribution may vary depending on etiology.^[2,4,10, 24–26]

This study has several limitations. First, its retrospective design limits control over confounding variables and introduces potential selection bias. Second, the relatively small sample size, particularly after subgrouping, reduces statistical power and may limit generalizability. Third, although radiographic endpoints represent an important and objective outcome measure, functional outcomes were not evaluated. The inclusion of patient-reported outcomes or functional recovery as secondary endpoints could provide a more comprehensive assessment of treatment efficacy.

Additionally, systemic corticosteroid exposure was treated as a binary variable, without accounting for dosage, duration, or indication for use. These factors may influence both disease severity and treatment response. Systemic comorbidities, which could also affect healing and progression, were not comprehensively assessed.

Despite these limitations, the study's strengths include the homogeneity of disease stage (Ficat-Arlet stage IIa), consistent use of a standardized surgical technique, and focused evaluation of a single etiologic factor (corticosteroid exposure).

Conclusion

Systemic corticosteroid exposure does not appear to significantly impair radiological outcomes following CD in early-stage non-traumatic ONFH, though larger studies are needed to confirm this observation. Timely diagnosis and intervention remain critical, and prior corticosteroid exposure alone should not preclude the consideration of joint-preserving surgical options in appropriately selected patients.

Disclosures

Ethics Committee Approval: This study was approved by the Metin Sabanci Baltalimani Bone Diseases Training and Research Hospital Institutional Ethics Committee (Date: 04.07.2025, Decision no: 38-290).

Informed Consent: Written informed consents were obtained from all the patients.

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