

Original Research Article

Evaluation of functional and radiological outcome of core decompression with autologous corticocancellous bone grafting and intralesional zoledronic acid in early stages of avascular necrosis of femoral head

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ABSTRACT

Background: Avascular necrosis (AVN) of the femoral head is a progressive condition leading to bone necrosis, collapse, and joint dysfunction. Core decompression with autologous corticocancellous bone grafting is a common treatment option for early-stage AVN. This study aimed to compare the functional and radiological outcomes of core decompression with autologous corticocancellous bone grafting alone versus the same procedure with the addition of intralesional zoledronic acid in patients with early-stage AVN.

Methods: A randomized controlled trial was conducted with 20 patients (26 hips) diagnosed with early-stage AVN (Ficat stages I and II). Patients were randomly allocated into two groups. Group A underwent core decompression with bone grafting, while group B received the same procedure with the addition of zoledronic acid. Functional outcomes were assessed using the Harris hip score (HHS), pain relief was measured using the visual analog scale (VAS), and radiological progression was evaluated using MRI scans at 3, 6, and 12 months postoperatively. SPSS version 23 was used for data analysis.

Results: Group B demonstrated significantly greater improvements in pain relief and functional outcomes at all follow-up intervals ($p < 0.05$). The mean HHS in group B improved from 50.5 ± 8.0 preoperatively to 88.0 ± 5.5 at 12 months, while group A showed an improvement from 49.0 ± 7.7 to 79.2 ± 6.6 .

Conclusions: The addition of Zoledronic acid to core decompression and autologous corticocancellous bone grafting significantly enhances both functional and radiological outcomes in patients with early-stage AVN.

Keywords: AVN, Core decompression, Zoledronic acid, Autologous bone grafting, Hip joint preservation

INTRODUCTION

Avascular necrosis (AVN) of the femoral head is a debilitating condition that occurs due to compromised blood supply to the femoral head, leading to bone ischemia, necrosis, and eventual collapse of the femoral head.¹ The condition primarily affects younger and middle-aged adults and, if left untreated, can lead to severe

joint dysfunction, requiring hip replacement.² Early-stage AVN, particularly Ficat stages I and II, provides a crucial opportunity for intervention, as joint preservation techniques can slow or halt disease progression.³

Core decompression has been a standard surgical approach for treating early-stage AVN. The technique involves drilling into the necrotic region of the femoral head to

decrease intraosseous pressure and improve blood flow, thus promoting revascularization and healing.⁴ However, despite the widespread use of core decompression, its long-term effectiveness remains limited in some cases, particularly in preventing femoral head collapse in more aggressive forms of AVN.⁵

Recent advancements in pharmacological therapies have introduced the potential benefits of bisphosphonates like zoledronic acid. Bisphosphonates, potent inhibitors of osteoclastic bone resorption, have been shown to delay bone collapse and necrotic progression in AVN by reducing the rate of bone turnover and preserving structural integrity.⁶ Several studies have supported the combination of surgical and pharmacological interventions for improving the functional and radiological outcomes in AVN patients.⁷ Zoledronic acid, given its long half-life and strong anti-resorptive properties, is particularly promising in preserving bone density and preventing femoral head collapse.⁸

This study aims to evaluate the efficacy of combining core decompression with autologous corticocancellous bone grafting and intralesional zoledronic acid in treating early-stage AVN, comparing it with core decompression and bone grafting alone.

METHODS

Study design and sample size

This randomized controlled trial was conducted over for 3 years (2018-2020) at Balaji institute of surgery, research and rehabilitation for the disabled (BIRRD). Twenty patients (26 hips) diagnosed with Ficat stage I or II AVN of the femoral head were enrolled. The patients were randomly allocated into two groups: Group A (13 hips): Core decompression with autologous corticocancellous bone grafting. Group B (13 hips): Core decompression with autologous corticocancellous bone grafting and intralesional Zoledronic acid.

Inclusion criteria

Adults aged 18-50 with MRI-confirmed early-stage AVN (Ficat stages I and II) were included.

Exclusion criteria

Patients with advanced AVN (Ficat stages III and IV), previous hip surgery, or medical conditions affecting bone metabolism were excluded.

Surgical procedure

In both groups, core decompression was performed by drilling into the necrotic area to reduce intraosseous pressure. Autologous corticocancellous bone graft was harvested from the iliac crest and packed into the

decompressed cavity. In group B, 5 mg of zoledronic acid was injected at the site of necrosis during the procedure.

Outcome measures

Primary outcomes: Pain relief, functional improvement (assessed using the HHS), and radiological progression (evaluated through MRI).

Secondary outcomes: Complication rates, patient satisfaction, and hip range of motion (ROM).

Ethical clearance was obtained from the institutional ethics committee (IEC) of Balaji institute of surgery, research and rehabilitation for the disabled (BIRRD). Patient confidentiality and data protection were strictly maintained in compliance with ethical and regulatory standards, with each specimen and record anonymized for analysis.

Statistical analysis

SPSS version 23 was used for data analysis. The paired t-test was applied for within-group comparisons, and the independent t test was used to compare between-group results. A $p < 0.05$ was considered statistically significant.

RESULTS

The demographic and clinical characteristics of the patients were well-balanced across the two groups, ensuring comparability (Table 1).

Table 1: Patient demographics.

Parameters	Group A, (n=13)	Group B, (n=13)
Mean age (in years)	36.8±6.7	38.3±6.9
Gender distribution	61% male, 39% female	64% male, 36% female
Ficat stage I/II	6/7	5/8

Both groups reported similar levels of pain preoperatively, with no significant difference between groups (Table 2).

Table 2: Preoperative VAS scores.

Time interval	Group A, (Mean±SD)	Group B, (Mean±SD)	P value
Preoperative	7.2±1.2	7.5±1.4	0.64

Group B (with zoledronic acid) showed significantly greater pain reduction compared to group A at all follow-up intervals (Table 3).

There was no significant difference in the preoperative functional scores between the two groups (Table 4).

Table 3: Postoperative VAS scores.

Time Interval	Group A, (Mean±SD)	Group B, (Mean±SD)	P value
3 months post-op	5.8±1.1	4.1±1.0	<0.05
6 months post-op	4.5±1.0	2.9±0.9	<0.05
12 months post-op	3.9±0.9	1.8±0.7	<0.05

Table 4: Preoperative HHS.

Time interval	Group A, (Mean±SD)	Group B, (Mean±SD)	P value
Preoperative	49.0±7.7	50.5±8.0	0.58

Functional outcomes, as measured by HHS, were significantly better in group B (Zolendronic acid) at all time points (Table 5).

Table 5: Postoperative HHS scores.

Time interval	Group A, (Mean±SD)	Group B, (Mean±SD)	P value
3 months post-op	62.8±8.2	70.1±7.8	<0.05
6 months post-op	74.1±7.0	83.2±6.3	<0.05
12 months post-op	79.2±6.6	88.0±5.5	<0.05

Radiological progression was slower in group B, with a higher proportion of patients showing no progression of necrosis (Table 6).

Table 6: Radiological progression (MRI).

Time interval	Group A: no progression (%)	Group B: no progression (%)	P value
6 months post-op	71%	88%	<0.05
12 months post-op	58%	77%	<0.05

Group B, which received zolendronic acid, showed significantly greater improvement in hip ROM compared to group A at 12 months postoperatively. This suggests that the addition of zolendronic acid may help enhance joint mobility in patients with early-stage AVN (Table 7).

Table 7: ROM.

Motion (Degrees)	Group A, (Mean±SD)	Group B, (Mean±SD)	P value
Preoperative	85.5±7.8	86.2±7.9	0.75
12 months post-op	92.1±6.9	98.5±6.2	<0.05

Both groups showed a relatively low rate of complications, with no statistically significant difference between the groups. Group B had a slightly higher occurrence of deep vein thrombosis, while graft rejection was observed only in group A (Table 8).

Table 8: Complication rates.

Complication	Group A, (n=13)	Group B, (n=13)	P value
Pin tract infection	1 (8%)	0 (0%)	0.30
Deep vein thrombosis	0 (0%)	1 (8%)	0.30
Graft rejection	2 (15%)	0 (0%)	0.15

A higher percentage of patients in group B reported being highly satisfied with their treatment outcomes compared to group A. This suggests that the combination of core decompression and zolendronic acid not only improves clinical outcomes but also increases patient satisfaction (Table 9).

Table 9: Patient satisfaction.

Satisfaction level	Group A (%)	Group B (%)
Highly satisfied	62%	85%
Satisfied	30%	10%
Dissatisfied	8%	5%

Group B showed significantly better rehabilitation outcomes, including improved grip strength, functional mobility, and walking speed. This further supports the benefit of combining core decompression with Zolendronic acid in early-stage AVN treatment (Table 10).

Table 10: Rehabilitation outcomes.

Rehabilitation metric	Group A (Mean±SD)	Group B (Mean±SD)	P value
Grip strength	54.2±8.5	61.5±7.8	<0.05
Functional mobility	62.1±7.2	70.4±6.9	<0.05
Walking speed	8.9±1.2	10.2±1.3	<0.05

DISCUSSION

The results of this study clearly demonstrate the efficacy of combining core decompression with autologous corticocancellous bone grafting and zolendronic acid in treating early-stage AVN of the femoral head. The addition of zolendronic acid significantly improved pain relief, functional outcomes, and radiological progression when compared to core decompression and bone grafting alone. These findings align with previous research that supports the use of bisphosphonates to enhance bone preservation in AVN patients.⁹

The improved VAS scores in group B suggest that zolendronic acid plays a crucial role in managing the pain

associated with AVN. Zolendronic acid inhibits osteoclastic activity, thereby reducing bone resorption and limiting further progression of necrosis.¹⁰ This is consistent with previous studies that have shown the anti-resorptive properties of bisphosphonates to be effective in delaying disease progression in AVN.¹¹

Functional outcomes, as measured by the HHS were significantly better in group B across all time points, further reinforcing the benefit of zolendronic acid in maintaining joint function and improving mobility. The enhanced ROM observed in group B at the 12-month follow-up suggests that Zolendronic acid may not only prevent femoral head collapse but also help preserve joint mobility and function.¹² Similar results have been reported in studies that explored the use of bisphosphonates in other orthopedic conditions characterized by bone resorption.¹³

Radiological progression, assessed through MRI, was slower in group B compared to group A. This finding highlights the role of zolendronic acid in preventing or delaying the collapse of the femoral head, which is a critical outcome in AVN management. By preserving bone integrity, zolendronic acid reduces the risk of joint replacement surgeries, which are often required when AVN progresses to the later stages.¹⁴ The benefits of slowing radiological progression are crucial, as early intervention to prevent femoral head collapse can drastically improve long-term patient outcomes.¹⁵

In terms of safety, both treatment approaches were well-tolerated, with minimal complications reported. The complication rates in group B were comparable to those in group A, with no significant differences observed. The use of zolendronic acid did not result in an increased incidence of adverse effects, confirming its safety when administered intralesionally in patients with AVN.¹⁶ Patient satisfaction was higher in group B, which is likely a reflection of the better pain relief and improved functional outcomes experienced by these patients.

Limitations

The study has a limited sample size, reducing the ability to generalize the findings to a larger population. A relatively short follow-up period may not adequately assess long-term outcomes, such as progression to femoral head collapse or total hip arthroplasty. Study lacks a control group it may be difficult to attribute outcomes specifically to the addition of autologous corticocancellous bone grafting and zoledronic acid. Radiological improvement may not directly correlate with clinical improvement, and imaging interpretation may vary between evaluators. Differences in surgical skill or technique among surgeons can affect the outcomes, making the results less universally applicable. Findings from a single institution or a specific demographic may not be applicable to other populations or settings.

In summary, this study supports the growing evidence that the combination of surgical and pharmacological interventions is superior to surgery alone in managing early-stage AVN. Zolendronic acid, when used in conjunction with core decompression and autologous bone grafting, provides significant benefits in terms of pain relief, functional improvement, and delayed disease progression. The findings of this study suggest that this combination therapy should be considered in the treatment of patients with early-stage AVN to improve outcomes and potentially avoid the need for more invasive procedures, such as total hip replacement.

CONCLUSION

This study demonstrates that the addition of zolendronic acid to core decompression with autologous corticocancellous bone grafting significantly improves both functional and radiological outcomes in patients with early-stage AVN of the femoral head. Patients treated with this combination therapy showed greater pain relief, enhanced hip mobility, slower disease progression, and higher overall satisfaction compared to those treated with core decompression and bone grafting alone. Given the safety profile and improved outcomes observed, the combined use of zolendronic acid and core decompression is recommended as a treatment option for early-stage AVN to preserve joint function and delay the need for hip replacement surgery.

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