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# Resection of Femoral Head–Neck Junction Osteoid Osteoma via Minimally Invasive Direct Anterior Approach: A Case Series and Review of Literature

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## Abstract

Our aim was to introduce a new minimally invasive approach for surgical excision of femoral head–neck junction osteoid osteoma (FHNJOO) and review the available literature regarding its clinical manifestations and treatment methods. We included nine patients with FHNJOO in this series, who underwent resection via the minimally invasive direct anterior approach (DAA), from January 2010 to 2013. The functional outcomes were hip range of motion (ROM), visual analogue scale for pain (VAS), and Harris hip score (HHS), which were assessed pre- and postoperatively at 3 months at the last follow-up. We had nine patients with a mean age of $17.25 \pm 6.75$ years. The mean diagnosis delay was $23.56 \pm 4.67$ months. We had a mean follow-up of $93.67 \pm 18.02$ months. The hip ROM, VAS, and HHS were significantly improved from $97.78 \pm 8.70$ degrees to $121.11 \pm 4.86$ degrees, $63.93 \pm 10.47$ to $99.11 \pm 1.76$ degrees, and $7.3 \pm 1.5$ to $0.1 \pm 0.3$ degrees at 3-month and the last follow-up, respectively ($p < 0.001$). We observed no recurrence or complications. The minimally invasive DAA approach for surgical resection of FHNJOO can provide immediate pain relief and improve hip functional scores with no complication or recurrence on long-term follow-up. It provides easy and complete access to the lesion and causes no morbidity due to minimal dissection.

**Keywords**
- osteoid osteoma (OO)
- direct anterior approach
- femoral head–neck junction

Osteoid osteoma (OO) is a benign bone tumor comprising approximately 13% of all benign bone neoplasms.[1] It is characterized by a central nidus, which consists of a highly vascularized osteoid tissue surrounded by sclerotic bone and is usually less than 1cm.[2,3] It typically affects patients 5 to 30 years old with a 1.6–4:1 male-to-female ratio.[3] It can occur as a cortical, cancellous, or subperiosteal lesion with the cortical being the most common.[4] Although any bone can be affected, at least 50% of reports were in the lower extremity with 25 to 27% in the proximal zones.[3]

Intra-articular OOs comprise 10% of all OOs.[5,6] They can cause atypical clinical and radiological presentations that would mislead the diagnosis. These include a limited range of motion (ROM), flexion contracture, and swelling of the affected joint.[6,7] The differential diagnoses of the hip intra-articular OO include septic or inflammatory arthritis, synovitis, avascular necrosis, and fracture.[5] Thus, the diagnosis is

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sometimes delayed for almost more than 2 years from the onset of symptoms, which can cause significant morbidity for the patient.[8]

There are a few reports about the nonoperative management of OO, which were mostly associated with incomplete pain resolution.[8] Moreover, the side effects associated with high doses of analgesics and tolerance to them would lead us to consider other treatment options.[2] Studies have shown that most patients require surgical treatment for complete pain relief.[3] Surgical options include wide excision, intralesional excision with minimal bone removal, and less invasive techniques such as arthroscopic, computed tomography (CT), or magnetic resonance imaging (MRI)-guided core drill excision, ethanol injection, interstitial laser photocoagulation, and radio frequency ablation (RFA).[8] However, there is general agreement that complete excision is the treatment of choice and incomplete nidus removal leads to recurrence of symptoms.[9]

There are several approaches to remove a lesion in the femoral head and neck. Strong et al described three routes to access a femoral neck lesion.[10] The first is a minimally invasive approach, which involves drilling along the femoral neck and removing the lesion. It can potentially damage the epiphyseal growth plate. The second is a direct approach to joint, which involves opening a trapdoor to the lesion and removing it. The third is a direct approach to the articular surface via surgical hip dislocation, which has the risk of damage to articular surface as described by Mont et al.[11,12] Liu et al have lately described the modified version of trapdoor procedure by surgical dislocation.[13] In recent literature, hip arthroscopy has gained popularity for intra-articular lesions. It has the advantage of not injuring the growth plate in children and can also address the synovitis.[14,15] Nevertheless, it may be difficult to identify and completely resect the lesion via arthroscopy.[16]

In this series, we presented our experience in the surgical excision of femoral head–neck junction OOs (FHNJOO) in nine patients using the minimally invasive direct anterior approach (DAA). To our knowledge, there is no report of using the minimally invasive DAA for FHNJOOs in the literature. Our aim was to present our results and to discuss and review the available literature regarding its clinical picture and treatment methods.

## Methods

In this case series, we included nine patients with FHNJOO, who underwent resection via the minimally invasive DAA from January 2010 to January 2013. The senior author performed all the operations. The Institutional Review Board of Tehran university of medical science reviewed and approved the study protocol and ethics. All the patients gave informed consent to participate in this study.

All the patients underwent standard pelvic radiography, CT scan, and MRI (►**Figs. 1** and **2**). The location of the lesion was assessed prior to surgery, as the deep posterior lesions of femoral head and neck could not be accessed using the DAA.

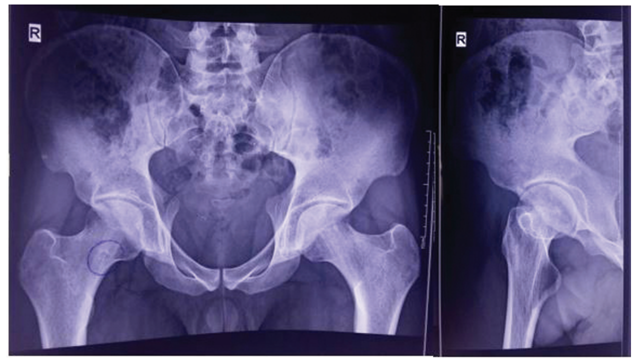


**Fig. 1** Anteroposterior and lateral X-ray of right hip that shows lytic lesion with sclerotic margin in the right head–neck junction ("bull's-eye" appearance).

All the diagnoses were confirmed by histopathological exam by a musculoskeletal pathologist.

The surgical data of patients were extracted from their surgical notes in our patients' database. The functional outcomes of study included hip ROM, visual analogue scale for pain (VAS), and Harris hip score (HHS), which were assessed both pre- and postoperatively after 3 months and at the last follow-up. We measured the diagnosis delay as the time elapsed from initial symptoms to confirmed diagnosis of OO based on the history taken from patients and their medical records.

### Surgical Technique

The patient was positioned supine on a radiolucent table. Once prepped and draped, an incision (8–10 cm) was made one fingerbreadth distal and three fingerbreadths lateral to anterior superior iliac spine aiming toward the lateral patellar border. The superficial fascia was incised, and finger dissection was performed around the medial border of the muscle belly to sweep it laterally. A blunt cobra was then placed over the superior femoral neck followed by division of the deep investing fascia. The ascending branches of the lateral femoral circumflex artery were ligated. We placed a second blunt cobra along the inferior femoral neck to

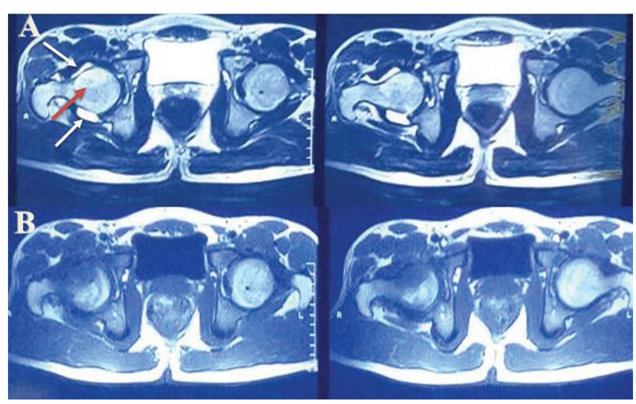


**Fig. 2** **(A)** The axial cut of hip magnetic resonance imaging (MRI) (T2 signal) showing head–neck junction lesion (*red arrow*) with extensive surrounding edema (*white arrows*). **(B)** Axial cut of hip MRI in T1 sequences showing the lesion.

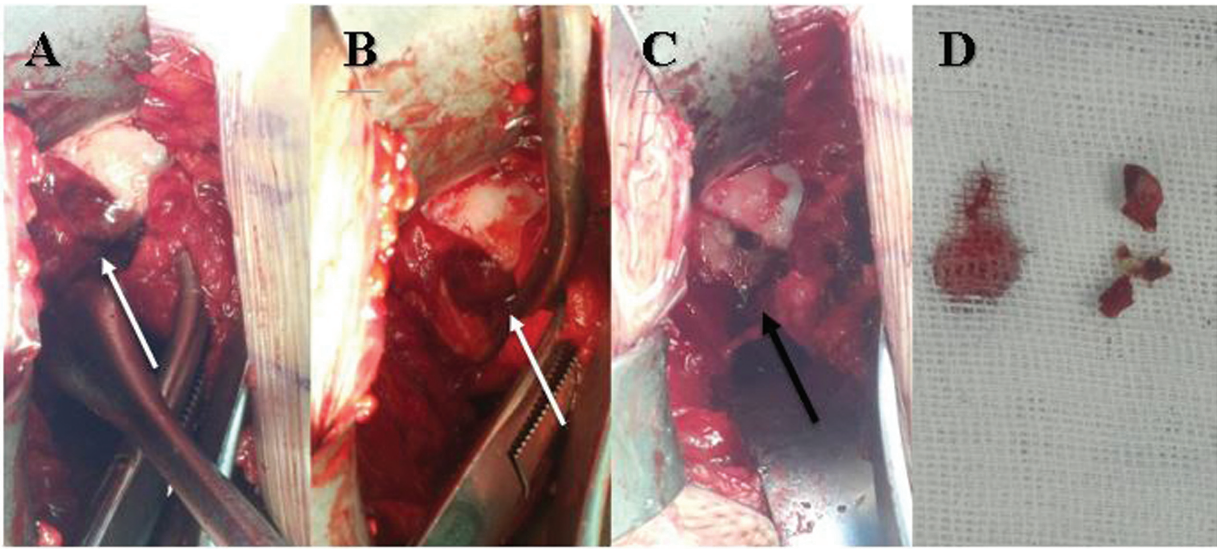


**Fig. 3** Perioperative images **(A, B)** showing resected lesion and empty hole in the femoral head–neck Junction (*white arrows*). Images (**C** and **D**) showing the hole impacted by bone-graft (*black arrow*) and the resected lesion.

retract the medial structures. Care should be taken not to put too much force on both cobra retractors and frequently let them free not to injure the retinacular vessels. A relaxing incision along the lateral margin of the reflected rectus head would facilitate placing a retractor over the anterior acetabulum. It should be perpendicular to inguinal ligament as medial placement can injure the femoral neurovascular structures. At this time, an H capsulotomy was performed with great care for retinacular vessels and with one limb parallel to acetabular margin and the other along base of the neck. A cortical window was opened based on the preoperative planning and the nidus was completely excised (►**Fig. 3**). The cavity margins were extended using high-speed burr. After proper hemostasis, standard layered wound closure was performed.

### Statistical Analysis

We used SPSS software version 25.0 for statistical analysis. Quantitative variables were presented as mean ± standard deviation. We used paired-samples *t*-test to compare the pre- and postoperative functional outcomes. We considered the significance level as *p*-value less than 0.05.

## Results

We had nine cases of FHNJOO undergoing surgical excision using the minimally invasive DAA. The detailed demographic, surgical, and functional data of patients are presented in ►**Table 1**. Except a 6-year-old girl, all the other patients were male. The mean age was 17.25 ± 6.75 years (range: 6–24). The mean diagnosis delay was 23.56 ± 4.67 months (range: 16–30). We had a mean follow-up duration of 93.67 ± 18.02 months (range: 68–115). All the patients had one nidus except one with two subperiosteal nidi, in whom the synovial fluid was bloody. The lesions were all in the femoral head–neck junction.

All the functional outcomes showed significant improvement postoperatively. The mean preoperative hip ROM was 97.78 ± 8.70 degrees mostly due to pain and flexion contracture, which significantly increased to 118.33 ± 3.53 degrees and 121.11 ± 4.86 degrees at 3-month and the last follow-up, respectively ($p < 0.001$). The HHS score also increased from a mean of 63.93 ± 10.47 to 97.56 ± 2.55 and 99.11 ± 1.76 at 3-month and the last follow-up, respectively ($p < 0.001$). The decrease in VAS was also significant, from 7.3 ± 1.5 to 0.6 ± 0.7 and 0.1 ± 0.3 at 3-month and the last follow-up, respectively ($p < 0.001$). We had no postoperative complication or recurrence in this study.

## Discussion

OO occurs more frequently in the lower than upper extremities, and within the lower extremity, it has a predilection for femoral neck.[3] Due to its intra-articular position, FHNJOO can cause confusion and delay in the diagnosis. Moreover, there is controversy over the technique of choice for its management among the various available techniques. In this study, we presented nine FHNJOO cases, which underwent surgical resection via the minimally invasive DAA with a mean follow-up of 93.67 ± 18.02 months. All the functional outcomes significantly improved postoperatively. We had no postoperative complication or recurrence over this follow-up period.

The mean time from the initial symptoms to confirmed diagnosis was 23.56 ± 4.67 months in our study. Most previous studies have also reported a diagnosis delay of at least 2 years for femoral neck OOs.[17–19] Many authors believe it is a diagnostic challenge for orthopaedic surgeons.[3,16,20,21] In femoral neck, an intra-articular OO can cause hip synovitis leading to atypical manifestations such as referred pain, muscle atrophy and weakness, flexion contracture, and decreased hip ROM.[5,16] Knowing the possibility of such

 

**Table 1** The demographic and clinical data of patients

| Patient no. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Mean | SD | *p*-Value[a] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | | Male | Male | Male | Female | Male | Male | Male | Male | Male | – | – | – |
| Age (y) | | 24 | 24 | 13 | 6 | 19 | 9 | 19 | 14 | 21 | 17.25 | 6.75 | – |
| Side | | Left | Left | Right | Right | Right | Left | Right | Left | Left | – | – | – |
| Nidus (*n*) | | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | – | – | – |
| VAS | Preop. | 6 | 8 | 7 | 8 | 10 | 6 | 9 | 6 | 6 | 7.3 | 1.5 | – |
| | Postop. (3 mo) | 1 | 1 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 0.6 | 0.7 | < 0.001 |
| | Postop. (last F/U) | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.3 | < 0.001 |
| Hip ROM | Preop. | 100 | 95 | 100 | 90 | 80 | 100 | 105 | 110 | 100 | 97.78 | 8.70 | – |
| | Postop. (3 mo) | 120 | 120 | 120 | 115 | 110 | 120 | 120 | 120 | 120 | 118.33 | 3.53 | < 0.001 |
| | Postop. (last F/U) | 125 | 125 | 120 | 120 | 110 | 125 | 120 | 120 | 125 | 121.11 | 4.86 | < 0.001 |
| HHS | Preop. | 58.00 | 54.85 | 70.85 | 57.85 | 46.40 | 70.85 | 68.85 | 80.85 | 66.85 | 63.93 | 10.47 | – |
| | Postop. (3 mo) | 96.00 | 97.00 | 96.00 | 100.00 | 93.00 | 100.00 | 100.00 | 100.00 | 96.00 | 97.56 | 2.55 | < 0.001 |
| | Postop. (last F/U) | 100.00 | 100.00 | 100.00 | 100.00 | 96.00 | 100.00 | 100.00 | 100.00 | 96.00 | 99.11 | 1.76 | < 0.001 |
| Diagnosis delay[b] (mo) | | 20 | 26 | 24 | 16 | 18 | 28 | 26 | 24 | 30 | 23.56 | 4.67 | – |
| F/U duration (mo) | | 115 | 110 | 112 | 90 | 86 | 72 | 82 | 68 | 108 | 93.67 | 18.02 | – |

Abbreviation: F/U, follow-up; HHS, Harris hip score; ROM, range of motion; VAS, visual analogue scale.
[a]Paired samples *t*-test was used to compare the pre- and postoperative functional outcomes.
[b]Diagnosis delay was measured as the time interval from initial symptoms to confirmed diagnosis of osteoid osteoma.

confusing presentation can reduce the diagnosis delay and prevent unnecessary further treatments.[3]

The use of CT imaging was shown to decrease the time to diagnosis. Moreover, CT scan was considered as the imaging modality of choice for intra-articular OO.[3] We used CT scan as the main diagnostic tool in this study.

Also, we performed histopathological confirmation of OO for our patients. DAA used in this study provided good intraoperative nidus identification and intralesional excision of the nidus with minimal bone removal. But, it was not possible evaluating histological diagnosis with other new surgical approach such as the arthroscopic method and invasive ablation treatment of the OO.[3]

Pain is the most common symptom in OO, which usually aggravates at night.[21] All our patients expressed complete pain relief after the surgery, so that VAS score improved from a mean 7.3/10 to 0.1/10 at a mean follow-up of $93.67 \pm 18.02$ months. Moreover, we had no recurrence over this period. Our results in pain relief were in line with those of other techniques. Lee et al reported complete pain relief following arthroscopic resection for intra-articular hip OO in two children.[22] Tamam et al also reported significant pain relief and an asymptomatic hip (4-month follow-up) after arthroscopic resection for subarticular acetabular OO.[23] Erol et al reported immediate and complete pain relief after minimally invasive intralesional extended curettage for OOs in 47 children.[24] Rosenthal et al demonstrated complete pain relief with following CT-guided RFA in 112 of 126 (89%) procedures.[25] However, Papathanassiou et al reported pain recurrence in three OOs (10%), one intra-articular medullary, and two extra-articular cortical lesions at 2, 6 and 4 months after RFA, respectively. Inadequate electrode positioning in the cortical lesions and articular damage in the intra-articular case were the main reasons for pain recurrence.[26]

In our study, the patients had limited hip ROM and mobility preoperatively. At the last follow-up, hip ROM and HHS were significantly improved in all our patients. Our findings were in line with results of previous studies suggesting that complete removal of OO is necessary for complete relief of symptoms. Erol et al reported early improved ROM of the involved extremities and mobilization of the patients within 2 days after minimal invasive intralesional extended curettage.[24] Marwan et al showed a significant improvement in HHS scores within 3 weeks following arthroscopic resection for hip OO.[27]

There are several options for the operative treatment of OO including open surgical excision, RFA, imaging-guided excision, and arthroscopic resection.[28] When it affects deep areas of the hip joint, for example, the medial wall of acetabulum or the medial cortex of FHNJ as in our cases, it is hard to reach for the nidus without injuring the normal surrounding bone.[5] Therefore, we used the minimally invasive DAA. The most important advantages of this approach were the more rapid postoperative recovery and better access with minimal damage.

The traditional open en bloc excision technique provides easy access to tumor site and the possibility for a wide resection margin. However, it entails a large incision, wide dissection, sometimes a surgical dislocation, and too much normal bone removal.[29,30] Moreover, it is associated with a longer recovery time and risk of avascular necrosis.[3]

Erol et al in 2017 reported the results of minimally invasive intralesional extended curettage for extremity OOs in 47 children. They had no surgical complications, including injury to neurovascular structures, infection, and wound problems with no local recurrence after 12-month follow-up.[24] However, the femoral neck and pelvis were not included in this series.

Percutaneous CT-guided RFA has shown acceptable safety and efficacy in treatment of extra-articular OOs.[30–33] Sans et al reported cure and complication rates of 84 and 24% in 38 patients, respectively. The major complications were two femoral fractures and a chronic osteomyelitis.[34] Roqueplan et al reported a success rate of 95% with one myalgia and two skin burns at 2-year follow-up.[35] In a large study, Rosenthal et al used this technique for primary treatment in 249, recurrence after open excision in 14, and post-RFA recurrence in eight patients. The success rate for primary and recurrent lesions were 91 and 60%, respectively. Cellulitis and sympathetic dystrophy were the complications.[25] Papathanassiou et al showed a primary cure rate of 89.6% in their series of 29 patients. Nevertheless, they reported two important complications associated with intra-articular OOs: a delayed hip osteoarthritis due to cartilage damage, and a septic arthritis with cutaneous fistula due to needle tract infection. They concluded that thorough planning and special care are necessary when treating intra-articular OOs by RFA.[26] Moreover, some studies have demonstrated that complete tumor ablation by RFA is not always possible due to the short range (5mm) of effective ablation around electrode. They also pointed out that this technique is not safe in perineurovascular and juxta-articular regions. Moreover, there is a high probability of incomplete excision in these areas.[8,36]

Recently, hip arthroscopy has been suggested as an effective and safe technique for excision of juxta- and intra-articular OOs.[27] Tamam et al in 2015 published a report recommending this technique in juxta-articular OOs.[23] Lee et al showed that it is a noninvasive option for intra-articular hip OO in children, which can relieve symptoms, prevent osteoarthritis, and concomitantly address the synovitis.[22] Marwan et al recently published a systematic review of 10 acetabular OOs undergoing arthroscopic resection (eight) or RFA (two) and reported a success rate of more than 90%.[27] Denker et al mentioned benefits like protection of the articular cartilage and minimal risk of avascular necrosis, although they reported risks such as neurapraxia, labral damage, and fluid extravasation.[14] Some disadvantages have also been reported using this technique. Some studies reported degenerative changes following arthroscopic ablation, which may have been caused by long-term synovitis or the proximity of tumor to articular surface.[14,15] There is also risk of neurovascular injury during portal placement, especially the posterior retinacular vessels and sciatic nerve.[22] Another limit is lack of full access to and poor visualization of lesions in sites such as intramedullary OOs, which can lead to incomplete resection and higher recurrence rate. It also results in no or a poor sample for histopathologic diagnosis.[3] However, using the minimally invasive DAA, we had no such problem. It provides a good access to the lesion and intraoperative identification of nidus, so that we could perform intralesional excision of the nidus with minimal bone removal.

In summary, our findings showed that minimally invasive DAA for resection of FHNJOO provides rapid recovery with seemingly less muscle damage, shorter operating time, and less blood loss than the traditional method. Moreover, this approach provides an easier and more complete access to intra-articular hip lesions compared with the recently-developed approaches such as arthroscopic resection/RFA. However, to precisely delineate the superiority of either methods, further comparative studies are required, that is, to compare between our approach and nonoperative treatment or the traditional method, and we cannot draw any absolute conclusion based on the current study. Our study can be a part of future meta-analyses done to compare all the methods of treatment of FHNJOO.

## Limitations

We had three major limitations in this study. First, to draw a stronger conclusion, it was better to have a comparative group of patients treated either nonoperatively or by another surgical approach to compare between both methods. However, unfortunately, all the cases managed in our institute had been operated using the same minimally invasive DAA. Second, this approach cannot provide access to lesions in deep posterior areas of femoral head–neck. Third, our sample size was small (nine patients), which is due to the relative rarity of FHNJOOs and that we reported the results of cases in one center. We think further multicenter studies are needed to fully elucidate the outcomes of this approach in FHNJOOs. Finally, we had problems regarding the follow-up of some patients, for which we did a virtual visit via phone or video call.

## Conclusion

The minimally invasive DAA approach for surgical resection of FHNJOO can provide immediate pain relief and improve hip functional scores with no complication or recurrence on long-term follow-up. It can be considered as one of the useful surgical approaches for intra-articular proximal femoral OOs, which provides easy and complete access to the lesion and causes no morbidity due to minimal dissection.

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Conflict of Interest
None declared.

 

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