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CASE REPORT

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Arthroscopic-assisted uni-portal non-coaxial endoscopic surgery treatment of fibrous dysplasia of the femur: a minimally invasive alternative to open surgery

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Abstract

Background Fibrous dysplasia of bone (FD) is a rare skeletal disorder. Traditional surgical options may have disadvantages such as greater trauma, incomplete curettage and recurrence risk. In this report, we introduce the technique for the treatment of fibrous dysplasia of the femur with Arthroscopic-assisted uni-portal non-coaxial endoscopic surgery (AUNES) and evaluate its feasibility.

Case presentation We described a 49-year-old female patient with an elliptical lesion measuring approximately 4.3 cm × 4.2 cm in the proximal left femur. Due to the limitations of traditional open surgery—significant trauma, incomplete curettage, and a high risk of recurrence—we performed tumor curettage and bone graft fusion with AUNES assistance for the first time. The AUNES endoscopy provided a clear surgical field, precise lesion boundaries, thorough curettage, and minimal blood loss. Postoperative pathology confirmed fibrous dysplasia. At the 1-month and 3-month postoperative follow-ups, the patient's surgical wound healed well without complications. DR and CT scans showed satisfactory graft placement and bone fusion.

Conclusion This case report demonstrates that AUNES-assisted tumor lesion curettage and bone grafting fusion surgery for FD is safe and feasible. It offers several advantages, including minimal invasiveness, a wide surgical field, thorough lesion curettage, and a low postoperative recurrence rate.

Keywords Arthroscopic-assisted uni-portal non-coaxial endoscopic surgery, Fibrous dysplasia of bone, Minimally invasive

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Background

Fibrous dysplasia of bone (FD) is a rare congenital benign intramedullary fibro-osseous lesion, with an incidence of approximately 1 in 5,000 to 10,000 individuals, accounting for 2.5–5% of benign bone tumors [1, 2]. FD is categorized into three subtypes: monostotic fibrous dysplasia, polyostotic fibrous dysplasia, and McCune-Albright syndrome (MAS). Among these, monostotic fibrous dysplasia is the most common, accounting for approximately 80% of FD cases [3]. FD can affect any bone in the human body, with the femur and craniofacial bones being the most commonly affected sites. It can lead to symptoms such as pain, deformity, and pathological fractures [4].

The treatment of FD primarily includes conservative treatment represented by bisphosphonates and surgical intervention. Although drug therapy can alleviate symptoms, it is not effective in halting the progression of FD. Therefore, surgical treatment remains the preferred option for most patients. Conventional surgical approaches typically involve lesion curettage, bone grafting, and internal fixation [5, 6]. However, traditional surgical approaches have certain limitations. Excessively large incisions undoubtedly increase patient trauma, whereas smaller incisions often restrict the surgical field, making it challenging for surgeons to accurately determine the lesion boundaries. This can result in incomplete lesion removal, thereby increasing the risk of recurrence. Consequently, it is imperative to explore novel minimally invasive techniques. Here, we present the first reported case of treating proximal femoral FD using arthroscopic-assisted uni-portal non-coaxial endoscopic surgery (AUNES). This technique, which facilitates lesion curettage and bone grafting under AUNES guidance, offers advantages such as a clear surgical field, complete lesion removal, low recurrence rates, and rapid patient recovery. Therefore, this technique may be considered a minimally invasive surgical treatment strategy for FD.

Case presentation

A 49-year-old female patient was admitted to the hospital after a physical examination revealed a lesion in the left proximal femur. After admission, no swelling or tenderness was found in the left hip and proximal femur. The digital radiograph (DR) of the left femur revealed an oval-shaped lesion with heterogeneous bone density in the proximal segment, measuring approximately 4.3 cm × 4.2 cm. The lesion had well-defined margins with sclerotic borders and contained patchy areas of slightly higher density. The lesion was clearly demarcated from the surrounding bone without evidence of periosteal reaction or soft tissue abnormalities (Fig. 1A). Contrast-enhanced MRI of the left femur indicated a cystic lesion in the proximal femur, suggesting a tumor-like lesion (Fig. 1B, C, D). Laboratory tests revealed no significant abnormalities, and the patient had no notable medical history of infection, surgery, or malignancy. The final preliminary diagnosis was a benign tumor-like lesion of the left femur. After completing the necessary preoperative preparations, we performed AUNES for lesion curettage and bone grafting on the left femur.

The surgical steps were as follows: (i) After general anesthesia, the patient was placed in the right lateral decubitus position. Routine surgical disinfection and draping were performed; (ii) A longitudinal incision was made on the proximal lateral aspect of the left thigh, centered on the lesion in the upper segment of the left femur. The fascia latae and deep fascia were dissected. Under fluoroscopic guidance, a localization needle was used to mark the outer edge of the lesion in the upper segment of the left femur, and the dilating cannula was progressively expanded (Fig. 2A, B). (iii) After confirming the correct position under fluoroscopy, the dilator was removed, and the working channel was filled with irrigating fluid. The endoscope was then slowly introduced along the working channel, with hemostasis achieved through water pressure. Normal saline was continuously irrigated to maintain a clear view under the scope; (iv) Under endoscopic guidance, a radiofrequency electrode was used to clean the periosteum of the outer surface of the lesion in the upper segment of the left femur. The radiofrequency electrode was then used to probe, and the anterior and posterior bone edges of the left femur were palpated; (v) A 2.5 cm × 1.5 cm bone window was created on the outer side of the upper segment of the left femur using an endoscopic burr. During surgery, a lesion approximately 4 cm × 4 cm in size was observed, with thinning of the bone and the presence of pale yellow fibrous tissue filling the medullary cavity (Fig. 2C, D); (vi) Different-sized curettes were used to thoroughly curette the tumor tissue from small to large, removing tissue until normal bone was visible (Fig. 2E); (vii) After using the radiofrequency electrode to coagulate the lesion cavity, the endoscope instruments were removed (Fig. 2F). The allograft bone was pushed into the lesion cavity through the bone graft funnel and press-fit into place (Fig. 2G); (viii) Finally, the incision was sutured, and the surgical incision was only about 1.5 cm (Fig. 2H). and the technology is illustrated in Fig. 3.

On the first postoperative day, the patient's surgical site gauze was dry with minimal exudate, and the patient experienced mild pain at the surgical area (VAS score of 3). A follow-up CT scan of the left femur showed complete filling of the lesion with allograft bone, and the fenestration length on the tumor surface is close to matches the transverse diameter of the tumor, eliminating blind spots in the anterolateral area (Fig. 4A, B, C). Pathological analysis revealed poorly organized woven bone-like tissue within a fibrous and vascular stroma, consistent

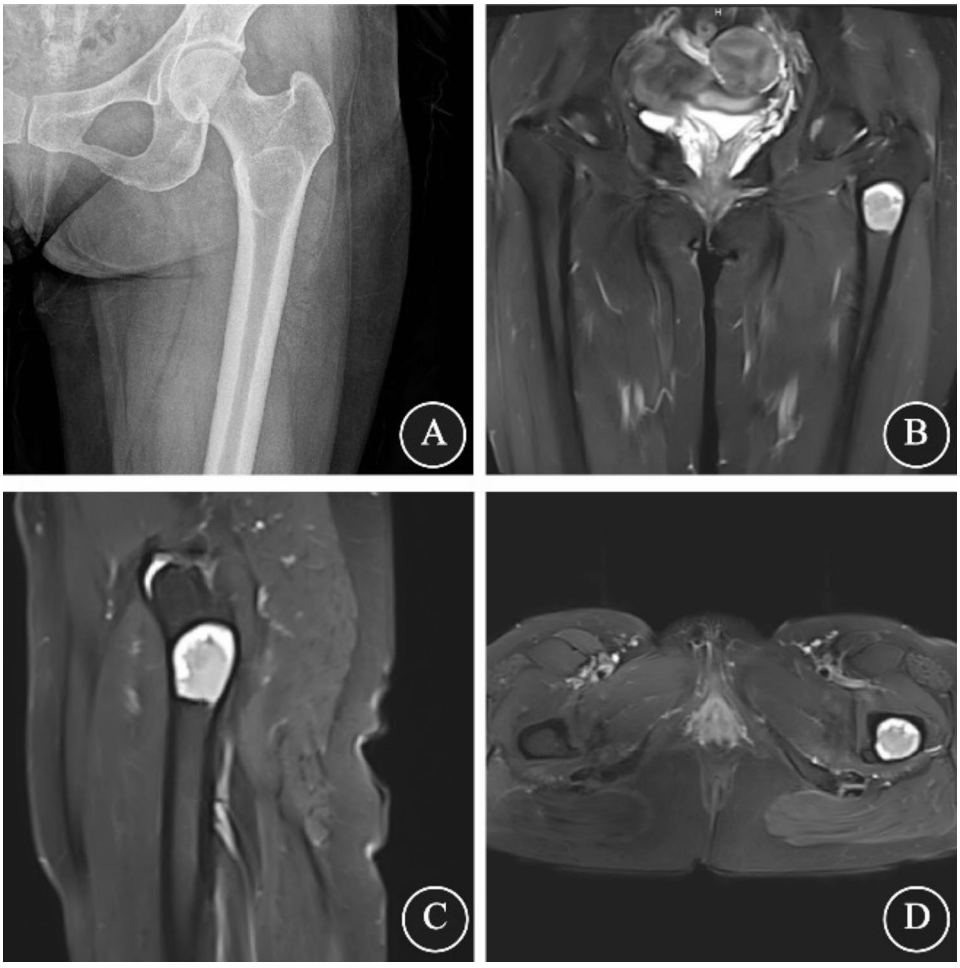

Fig. 1 (**A**) Preoperative anteroposterior radiograph of the left femur showing an oval-shaped lesion with heterogeneous bone density, measuring approximately 4.3 cm × 4.2 cm. (**B**, **C**, **D**) Preoperative MRI of the femur indicating a cystic lesion in the proximal segment of the left femur, suggestive of a tumor-like lesion

with a diagnosis of fibrous dysplasia (Fig. 5A, B, C). The patient was discharged on postoperative day 3. One month postoperatively, the patient was followed up and showed good incision healing with no pain at the surgical site (VAS score of 0). A follow-up DR of the left femur revealed good fusion of the allograft bone at the graft site (Fig. 6A, B). Moreover, the 3-month postoperative CT demonstrated improved allograft integration in the left femur compared to prior imaging (Fig. 6C, D), with no complications.

Discussion

FD is a benign fibrous bone tumor that predominantly affects children and adolescents. The exact pathogenesis remains controversial, but the prevailing hypothesis links it to genetic mutations. Specifically, mutations in the guanine nucleotide-binding protein alpha-stimulating activity polypeptide gene (GNAS) activate the G-protein alpha subunit, leading to excessive cAMP production. This results in defects in the differentiation of stem cells into osteoblasts, causing the formation of fibroblast-like cells and the production of poorly mineralized, disorganized bone matrix [7, 8]. The histological characteristics of FD include the replacement of normal bone tissue and bone marrow by abnormally proliferative fibrous tissue and immature trabecular bone [9]. The clinical presentation of FD varies. Some patients are asymptomatic or experience only mild pain, often discovered incidentally during routine examinations. In contrast, others may present with more severe symptoms, such as functional impairment, pathological fractures, and nerve damage [10, 11]. Most case reports of FD focus on the proximal femur, where imaging typically reveals a "ground-glass" appearance with well-defined borders, along with bilateral cortical thinning and bone sclerosis. In severe cases, the lesion in the proximal femur may lead to a "shepherd's crook" deformity [3, 12].

Currently, the main pharmacological treatments for FD include bisphosphonates and denosumab. These medications primarily work by inhibiting osteoclast activity and

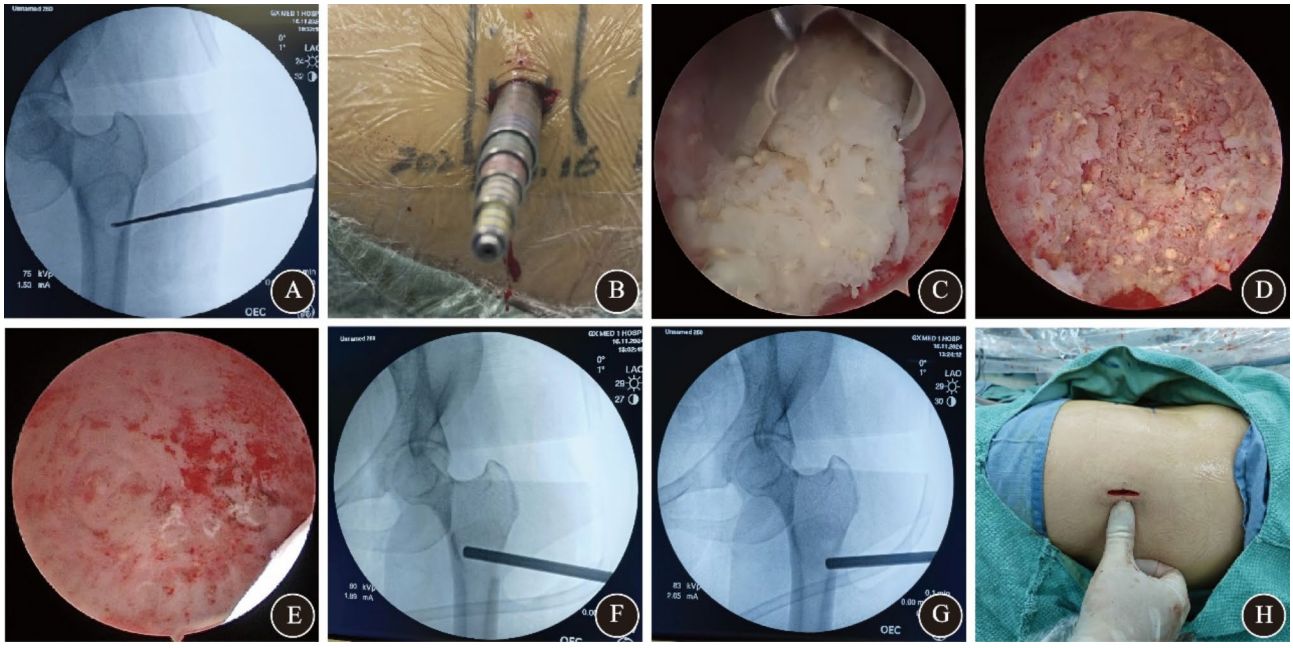

Fig. 2 (**A**) Intraoperative localization of the lesion using a guide pin. (**B**) Gradual dilation of the surgical channel during the procedure. (**C**) Removal of large pale yellow pathological tissue fragments with forceps. (**D**) Intraoperative view showing the medullary cavity of the proximal femur filled with pale yellow fibrous tissue. (**E**) Post-curettage view revealing normal bone tissue. (**F**, **G**) Before and after bone grafting, the lesion cavity was observed to be completely filled with allograft bone. (**H**) Postoperative incision length measuring approximately 1.5 cm

promoting osteoclast apoptosis, thereby alleviating pain [13, 14]. However, there is still some controversy regarding pharmacological treatments. Ozdemir Kutbay et al. [15] conducted a follow-up study on five FD patients treated with bisphosphonates. They found that while the patients experienced significant relief from bone pain, there was no improvement in bone density at the lesion sites, and no significant changes were observed on imaging. Therefore, they suggested that bisphosphonates may not effectively alleviate disease progression. Additionally, side effects such as osteonecrosis of the jaw have always been significant concerns in FD pharmacological treatments [16, 17]. As FD progresses and bone lesions become more severe, it can lead to pathological fractures and limb deformities, which severely impact the patient's quality of life. Therefore, surgery remains a crucial treatment for FD. For patients without significant deformities, lesion excision and bone grafting with internal fixation can yield good outcomes. However, for patients with deformities, in addition to lesion excision and bone grafting, osteotomy correction should also be performed. If the lesion is extensive, joint replacement may be considered [5, 6]. In the case of the patient described here, the lesion was localized and had not breached the bone cortex, making lesion curettage and bone grafting a viable option. However, conventional open surgery involves larger incisions and more tissue dissection, which can increase the risk of intraoperative complications. Moreover, accurately identifying the lesion's boundaries during surgery is challenging, and incomplete curettage significantly raises the risk of recurrence. According to the literature, the recurrence rate after FD curettage surgery is relatively high [12, 18, 19], with some reports, such as that of Guille et al. [20], indicating a recurrence rate as high as 66.6%. Therefore, accurately determining the tumor boundary during surgery to reduce recurrence rates has long been a major concern for orthopedic surgeons.

AUNES technology is derived from arthroscopic-assisted uni-portal spinal surgery (AUSS), a single-port non-coaxial endoscopic surgical technique proposed by Professor Song En in recent years [21]. It is characterized by minimal tissue trauma, a large working space, broad visual field, and high instrument compatibility. This technique has been applied to treat various degenerative diseases such as cervical spondylosis, lumbar disc herniation, and spinal stenosis. The authors have found that this technique is not only applicable to various spinal surgeries but can also be used for orthopedic surgeries at other body sites. Therefore, we are the first to apply the AUNES endoscopic technique for the treatment of FD of the femur in this report. With the assistance of endoscopic technology and internal lighting, the surgeon can directly visualize the lesion on the display screen. This provides a clear and bright surgical field, allowing for more precise identification of the lesion's boundaries and aiding in the evaluation of the extent of curettage. Furthermore, the continuous pressure exerted

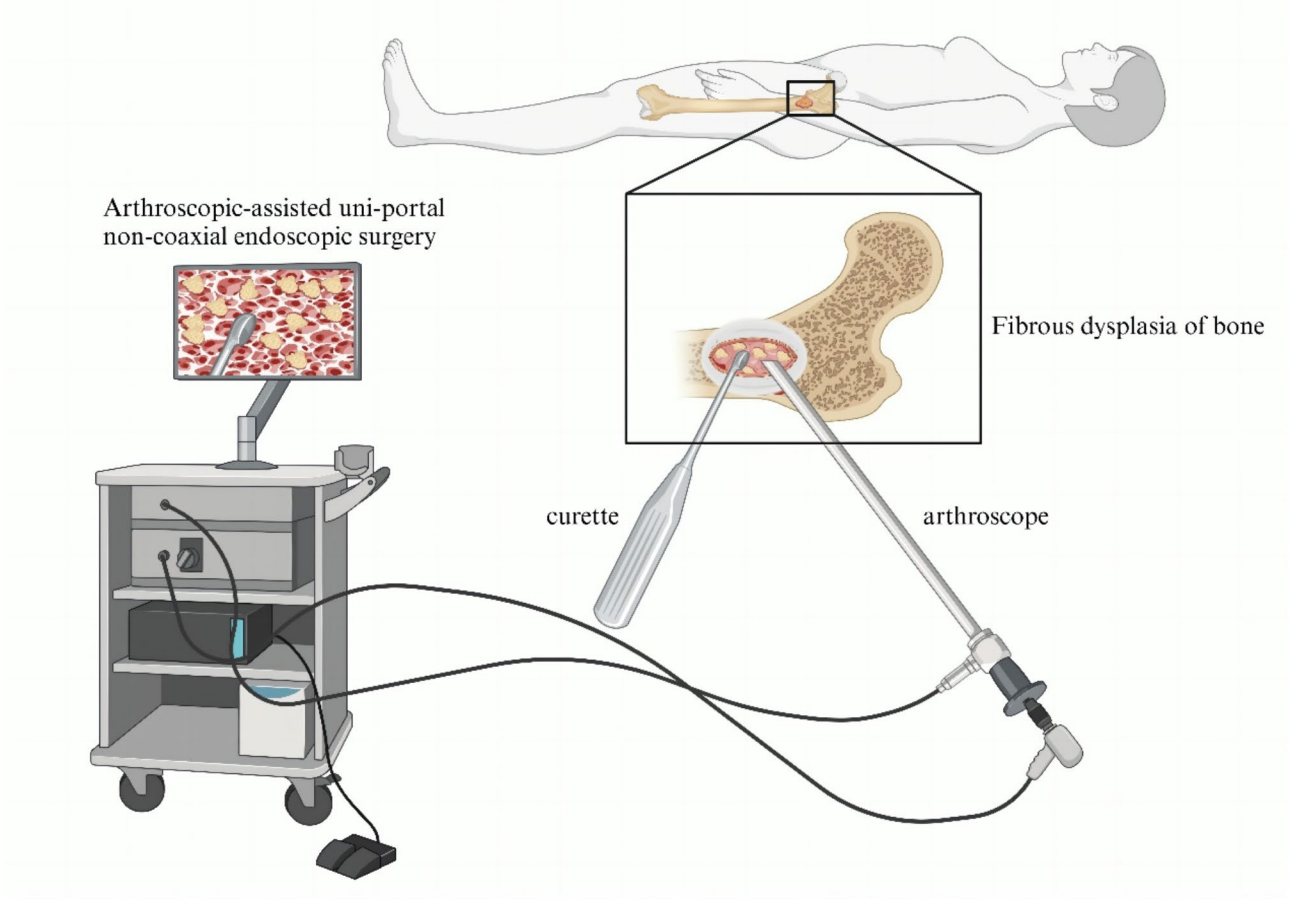

Fig. 3 Technical diagram of AUNES-assisted tumor lesion curettage and bone grafting fusion surgery for FD

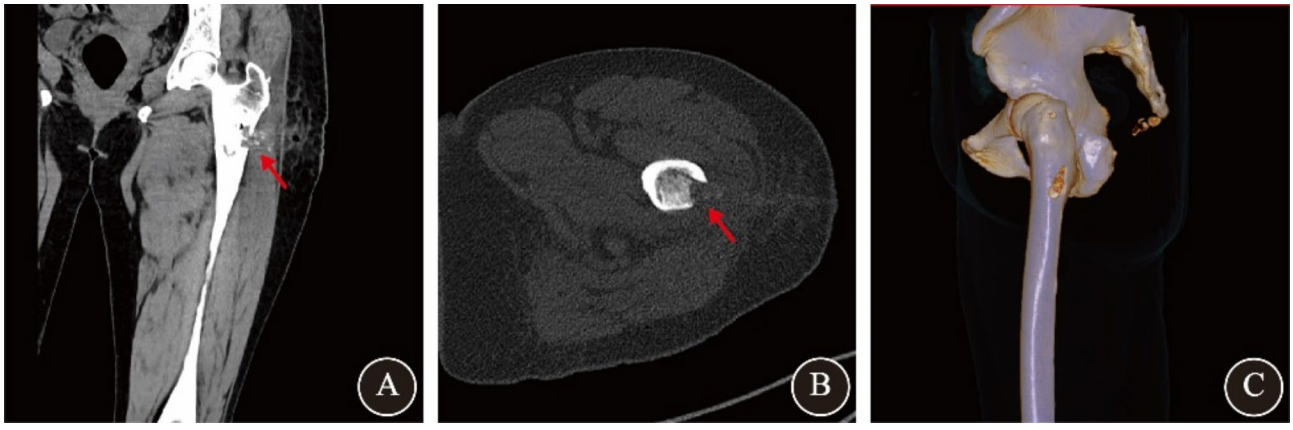

Fig. 4 (**A**) Postoperative coronal CT scan showing the lesion cavity completely filled with allograft bone (red arrow). (**B**) Postoperative axial CT scan indicating a relatively small surgical channel, and the fenestration length on the tumor surface is close to matches the transverse diameter of the tumor. (red arrow). (**C**) Postoperative 3D CT reconstruction demonstrating complete filling of the lesion cavity with allograft bone

by the irrigating fluid significantly reduces hemorrhage from the tumor site. However, there are some tips about this technique. Firstly, there are various ways to create the bone window, but the author recommends using the endoscopic burr due to its advantages of minimal bleeding, speed, and precision. Secondly, constructing the surgical access is crucial. Although conventional stepwise dilation of the access does separate the muscle fascia in the surgical area, the periosteal tissue is not effectively separated. Therefore, after removing the stepwise dilators, the surgeon should use a periosteal elevator to gently separate the periosteal fascia to allow smooth flow of

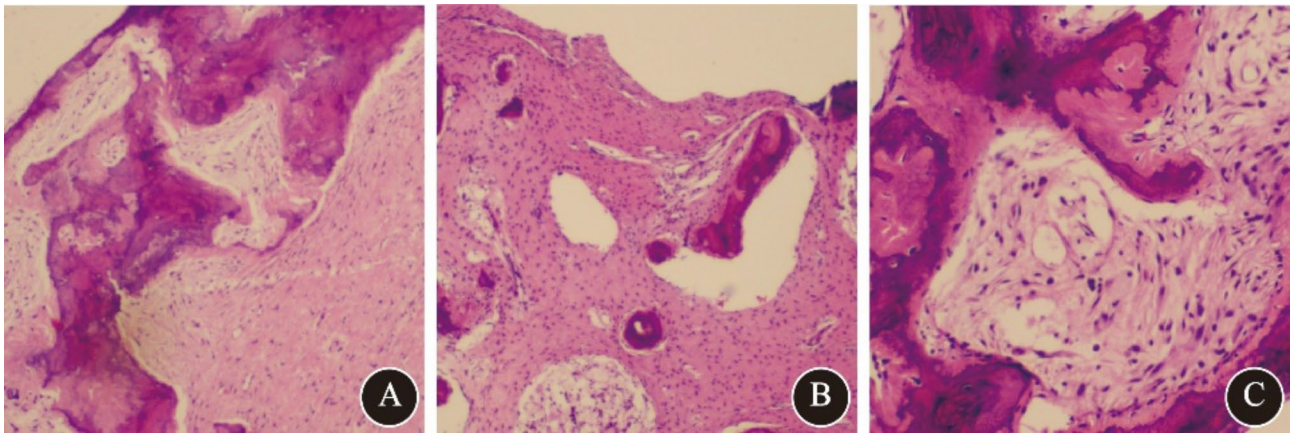

Fig. 5 (**A**, **B**, **C**) Histological examination showing irregularly woven bone-like structures within a fibrous vascular stroma, consistent with a diagnosis of fibrous dysplasia

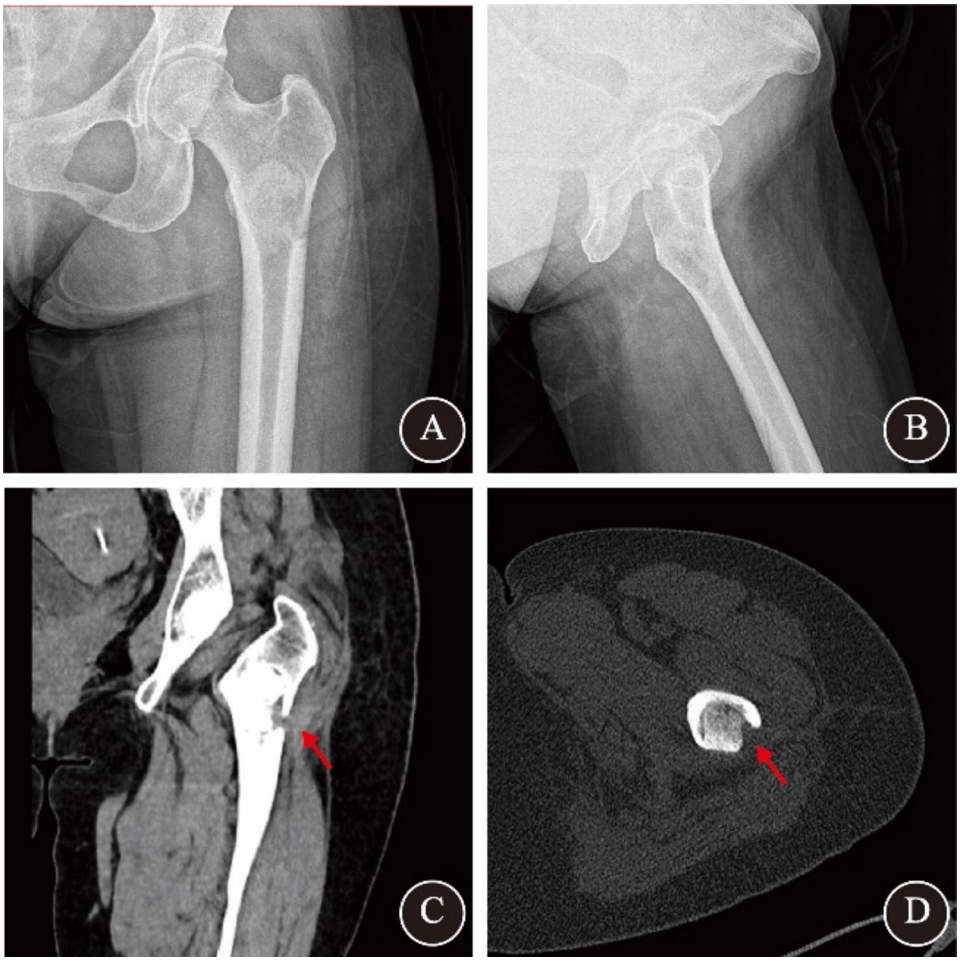

Fig. 6 (**A**, **B**) One month postoperatively, A follow-up DR of the left femur revealed good fusion of the allograft bone at the graft site. (**C**, **D**) The CT scan at three months post-operation showed improved integration of the left femoral allograft compared to previous imaging

the irrigation fluid, ensuring a clear surgical field. Additionally, controlling the pressure of the irrigation fluid is critical. If the pressure is too low, the surgical field may become unclear; if too high, it can lead to surrounding tissue edema. The surgeon finds that a pressure of 30–50 cm above the surgical area is optimal.

This technique is primarily suitable for treating monostotic FD or other benign bone tumors in the limbs.

However, it may not be appropriate for patients with polyostotic, pathological fractures associated with FD, or malignant bone tumors. Although the sample size is small and the follow-up period is short, which are limitations of this study, the authors believe that this surgical approach is simple to perform, and the endoscopic instruments are widely available. Therefore, it is worth promoting in clinical practice.

Conclusion

AUNES for lesion curettage and bone grafting in the treatment of femoral FD is an innovative surgical approach. This report demonstrates the feasibility and safety of the technique. It not only provides the surgeon with an excellent surgical field of view, making direct visualization of lesion curettage possible, but also significantly reduces the likelihood of postoperative recurrence in patients. This technique will offer orthopedic surgeons a new minimally invasive surgical option for the treatment of FD or other benign bone tumors in the future.

Abbreviations

FD	Fibrous dysplasia of bone
AUNES	Arthroscopic-assisted uni-portal non-coaxial endoscopic surgery
DR	Digital radiograph
GNAS	Guanine nucleotide-binding protein alpha-stimulating activity polypeptide gene
AUSS	Arthroscopic-assisted uni-portal spinal surgery

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Author contributions

YL, ES, and KL designed the study and critically revised the manuscript. MXY, WD, and WXH contributed to designing the study, and in drafting and critically revising the manuscript. HCT, SYL, and DTX were responsible for the data collection. JXD and HYQ were involved in the postsurgical evaluation of the patient. KL and JMH approved the final manuscript.

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Data availability

Data is provided within the manuscript.

Declarations

Ethics statement and consent to participate

All procedures performed in the study were in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The review and reporting of the cases was in accordance with the ethical standards of the Ethics Committee of the First Affiliated Hospital of Guangxi Medical University (Approval number: 2025-E0025).

Consent for publication

Written informed consent was obtained from the patient for publication of this case report.

Competing interests

The authors declare no competing interests.

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References

1. Kim HY, Shim JH, Heo CY. A rare skeletal disorder, fibrous dysplasia: A review of its pathogenesis and therapeutic prospects. Int J Mol Sci. 2023;24(21):15591.
2. Pai B, Ferdinand D. Fibrous dysplasia causing safeguarding concerns. Arch Dis Child. 2013;98(12):1003.
3. Kushchayeva YS, Kushchayev SV, Glushko TY, Tella SH, Teytelboym OM, Collins MT, et al. Fibrous dysplasia for radiologists: beyond ground glass bone matrix. Insights Imaging. 2018;9(6):1035–56.
4. Russell LW, Chandler FA. Fibrous dysplasia of bone. J Bone Joint Surg Am. 1950;32A(2):321–37.
5. Stanton RP. Surgery for fibrous dysplasia. J Bone Min Res. 2006;21(Suppl 2):P105–9.
6. Wang Y, Luo Y, Min L, Zhou Y, Wang J, Zhang Y, et al. The West China hospital radiographic classification for fibrous dysplasia in femur and adjacent bones: A retrospective analysis of 205 patients. Orthop Surg. 2022;14(9):2096–108.
7. Hartley I, Zhadina M, Collins MT, Boyce AM. Fibrous dysplasia of bone and McCune-Albright syndrome: A bench to bedside review. Calcif Tissue Int. 2019;104(5):517–29.
8. Zhao X, Deng P, Iglesias-Bartolome R, Amornphimoltham P, Steffen DJ, Jin Y, et al. Expression of an active Galpha(s) mutant in skeletal stem cells is sufficient and necessary for fibrous dysplasia initiation and maintenance. Proc Natl Acad Sci U S A. 2018;115(3):E428–37.
9. Hardoff R, Eisenberg D, Gross B. Bone scintigraphy in polyostotic fibrous dysplasia resembling multiple bone metastases. Clin Nucl Med. 1989;14(12):928–9.
10. Chapurlat RD, Orcel P. Fibrous dysplasia of bone and McCune-Albright syndrome. Best. Pract Res Clin Rheumatol. 2008;22(1):55–69.
11. Benhamou J, Gensburger D, Messiaen C, Chapurlat R. Prognostic factors from an epidemiologic evaluation of fibrous dysplasia of bone in a modern cohort: the FRANCEDYS study. J Bone Min Res. 2016;31(12):2167–72.
12. DiCaprio MR, Enneking WF. Fibrous dysplasia. Pathophysiology, evaluation, and treatment. J Bone Joint Surg Am. 2005;87(8):1848–64.
13. de Castro LF, Michel Z, Pan K, Taylor J, Szymczuk V, Paravastu S, et al. Safety and efficacy of denosumab for fibrous dysplasia of bone. N Engl J Med. 2023;388(8):766–8.
14. Chapurlat R, Legrand MA. Bisphosphonates for the treatment of fibrous dysplasia of bone. Bone. 2021;143:115784.
15. Ozdemir KN, Sarer YB, Kartal BE, Baydur SS, Saygili F. Characteristics and treatment results of 5 patients with fibrous dysplasia and review of the literature. Case Rep Endocrinol. 2015;2015:670809.
16. Metwally T, Burke A, Tsai JY, Collins MT, Boyce AM. Fibrous dysplasia and Medication-Related osteonecrosis of the jaw. J Oral Maxillofac Surg. 2016;74(10):1983–99.
17. Chapurlat RD, Hugueny P, Delmas PD, Meunier PJ. Treatment of fibrous dysplasia of bone with intravenous Pamidronate: long-term effectiveness and evaluation of predictors of response to treatment. Bone. 2004;35(1):235–42.
18. Rosario MS, Hayashi K, Yamamoto N, Takeuchi A, Miwa S, Taniguchi Y, et al. Functional and radiological outcomes of a minimally invasive surgical approach to monostotic fibrous dysplasia. World J Surg Oncol. 2017;15(1):1.
19. Enneking WF, Gearen PF. Fibrous dysplasia of the femoral neck. Treatment by cortical bone-grafting. J Bone Joint Surg Am. 1986;68(9):1415–22.
20. Guille JT, Kumar SJ, MacEwen GD. Fibrous dysplasia of the proximal part of the femur. Long-term results of curettage and bone-grafting and mechanical realignment. J Bone Joint Surg Am. 1998;80(5):648–58.
21. Wang F, Wang R, Zhang C, Song E, Li F. Clinical effects of arthroscopic-assisted uni-portal spinal surgery and unilateral bi-portal endoscopy on unilateral laminotomy for bilateral decompression in patients with lumbar spinal stenosis: a retrospective cohort study. J Orthop Surg Res. 2024;19(1):167.

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