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Ilizarov technique for treatment of a giant aneurysmal bone cyst at the distal femur: A case report

Xing-Yu Long, Feng Sun, Tao Wang, Ping Li, Zhong Tian, Xian-Wei Wu

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Abstract

BACKGROUND

Aneurysmal bone cyst (ABC) is a benign cystic of unknown etiology, characterized by multiple chambers and a high recurrence rate. Current treatment options include vascular embolization, surgical excision, curettage with cavity filling, sclerosing agent injection into the cavity, radiotherapy, and systemic drug therapy. Among these, surgical excision and curettage are the preferred treatment modalities. However, when the cyst reaches a large size, extensive removal of diseased tissue during surgery can hinder bone healing. In our department, we treated a case of a large ABC at the distal end of the femur in a child using the Ilizarov technique. The tumor was completely excised, and reconstruction was achieved through autologous femoral bone transfer. The follow-up at two years post-surgery indicated good results without tumor recurrence, and the growth and development of the child were essentially unaffected.

CASE SUMMARY

An 11-year-old boy was presented with an accidental fracture of his right leg. Despite having been examined at other hospitals, he had not received treatment. Given the potential for significant bone defects and the difficulty of the surgery, our doctors opted to use the Ilizarov technique to minimize harm to the patient. Upon admission, the patient underwent a needle biopsy and complete tumor resection-the Ilizarov technique assisted in the transport and reconstruction of the autologous femoral bone. Postoperatively, the patient exhibited regular follow-ups, during which bone transport was gradually performed, and the external fixation frame was removed on time. Follow-up X-rays of the right lower limb displayed no tumor recurrence, with a normal appearance. Bone formation at the

cutting site was satisfactory, and the union of the bone ends indicated good healing. After two years of follow-up, the patient had essentially returned to normal.

CONCLUSION

We successfully applied the Ilizarov technique to treat ABC, reducing the financial burden of patients and the pain of multiple surgeries. In cases where significant bone defects occur, the Ilizarov technique has demonstrated satisfactory therapeutic outcomes.

Key Words: Aneurysmal bone cyst; Ilizarov technique; Bone defect; Children; Case report

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Core Tip: This is a case report on the treatment of a pediatric patient with a large aneurysmal bone cyst of the distal femur using the Ilizarov technique. The surgical procedure of the patient was mainly documented. The patient was followed up for two years after the surgery, and the clinical healing and functional recovery of the patient were evaluated.

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INTRODUCTION

There are a variety of methods for benign bone neoplasia. Most of the early surgical methods are tumor lesion curettage and internal fixation with bone graft. However, long-term postoperative follow-up shows high recurrence rate, high rate of bone nonunion and high incidence of pathological fracture. There are more problems and challenges for children. For example, when the tumor is removed, where does the bone graft in children come from? The risk of bone resorption and rejection is greater when allogeneic bone is used. Therefore, after the introduction of bone transfer technology into China, following the principles of Lizarov technology, some doctors began to use external fixation system and single-arm external fixation system to carry out bone transfer technology to treat benign bone tumors, and problems such as postoperative tumor recurrence, bone graft difficulty, bone nonunion, pathological fracture and so on have been well solved. This case report describes the treatment of a pediatric patient with a large aneurysmal bone cyst (ABC) of the distal femur using the Ilizarov technique. The surgical procedure was thoroughly documented, and the patient was followed up for two years post-surgery to evaluate clinical healing and functional recovery.

CASE PRESENTATION

Chief complaints

Swelling and pain in the right knee, with limited movement for one week.

History of present illness

The mother reported that about a week ago, the child accidentally fell, resulting in swelling and pain in the right knee and restricted movement. They immediately sought medical attention at an external hospital, and after physical and X-rays examinations, the attending physician suspected a bone lesion in the distal right femur. However, no treatment was administered at that time. Currently, the family visits our outpatient clinic for continued care.

History of past illness

The little boy had been in good health before the fall.

Personal and family history

There were no genetic disorders in his family.

Physical examination

Physical examination revealed general normal conditions. A focused examination of the right thigh indicated significant swelling on the outer side of the distal femur tenderness, and percussion tenderness. The skin temperature of the affected area was slightly higher than that of the healthy side, but the skin color appeared normal. There was limited movement in the affected limb, but peripheral blood circulation and nerve function were normal.

Laboratory examinations

Nothing abnormal was detected.

Imaging examinations

Auxiliary examinations, including X-rays from the external hospital, indicated bone changes at the distal right femur on the outer side. Laboratory tests revealed no significant abnormalities. Preoperative comprehensive imaging, including knee computerized tomography (CT), enhanced CT, and magnetic resonance imaging, revealed a translucent area on the outer side of the lower end of the femoral shaft, measuring approximately 77 mm × 46 mm × 49 mm, with precise edges, no sclerosis, and expansive growth. The bone cortex in the affected area was significantly thinned, with visible sieve-like pore shadows, and the growth plate was intact (Figure 1).

MULTIDISCIPLINARY EXPERT CONSULTATION

Pathological diagnosis: A large amount of cystic wall-like tissue is visible in the submitted specimen. Some cyst walls are filled with blood, and some show spindle-shaped fibroblastic proliferation accompanied by a large number of multinucleated giant cells, osseous matrix, and reactive woven bone components. Nuclear division is observed, and occasionally atypical cells are seen in the fibrous tissue (Figure 2). After consultation by pathology experts at Shanghai Sixth Hospital, the final diagnosis is ABC.

FINAL DIAGNOSIS

The final diagnosis was ABC.

TREATMENT

After admission, the patient underwent thorough examinations, and no surgical contraindications were found. On the sixth day of admission, under lumbar anesthesia, a "right femoral bone puncture biopsy" was performed. The postoperative biopsy report indicated a benign tumor in the right femur, suggesting non-ossifying fibroma based on immunohistochemistry, with the following results: H3.3G34W(-), H3K36M(-), P16(-), SATB2(+), Ki-67(+, approximately 5%). On the 22nd day of admission, under general anesthesia, a "removal of the right femoral lesion with external fixation frame fixation and bone transportation biopsy" was conducted (Figure 3). The surgical procedure is as follows: (1) External fixation: The external fixation frame is used by inserting Kirschner wires into the proximal femur near the lesser trochanter, horizontally and vertically on the lateral bone surface. The cables are inserted from the distal side, away from the growth plate, and positioned horizontally. After prepositioning the external fixation frame, its position is confirmed under fluoroscopy in both anteroposterior and lateral views. After removing the external frame, a 0.5 cm skin incision is made at the proximal and distal Kirschner wire positions. A suitable nail rod is inserted using blunt dissection, and the external fixation frame is reattached. Nail clips are used to secure the proximal and distal rods, placing the distal clip horizontally. Once the tumor location is confirmed, it is secured by inserting three proximal, two transportation, and four distal rods at approximately 10 cm from the tumor's proximal end. Whether the rod lengths and positions are appropriate and that the external transportation fixation frame is in place is confirmed through fluoroscopy; (2) Thorough clearance of the tumor lesion: A 15 cm incision is made on the anterior and lateral sides of the lower femur, cutting through the skin. The tumor lesion is accessed through the lateral muscle gap of the femur, where the outer cortex appears soft and depressed upon palpation. An anterior-lateral window is created to access the tumor, and a large amount of bloody material flows out. The cyst contents are removed, revealing that the tumor had invaded the distal lateral femur and the growth plate. The tumor cyst wall is completely scraped off while protecting the growth plate. A rapid biopsy is taken from the cavity for pathological examination. After confirming the benign nature of the tumor through rapid pathology, the cavity is thoroughly flushed with ice saline, and the tumor nests are scraped off. After repeated flushing, the surrounding tissues are protected, the cavity is soaked twice with alcohol without water, and the tumor lesion is completely removed; and (3) Bone transportation: The pre-determined bone-cutting site is exposed at the proximal end of the incision. A lateral half-femur bone transport is performed, and a 2.0 mm hole is drilled approximately 10 cm from the proximal end of the tumor for lateral half-femur bone cutting. After drilling, two nail clips in the transportation segment are loosened. An anterior bone cut is made with a reciprocating saw, and the posterior bone tissue is cut with a bone knife. After confirming complete lateral half-mobility, the nail clips are tightened for fixation. The area is thoroughly irrigated with physiological saline, and bleeding is controlled. A harmful pressure drainage bottle is placed in the cavity, and the subcutaneous layers are closed in layers. The skin is sutured with absorbable thread, sterile gauze is applied, and the surgery is completed. Finally, the tissue from the femoral lesion is sent for biopsy again.

The patient had his stitches removed two weeks after the surgery and was discharged with instructions to wear a hip abduction orthosis for protection for two months. The family followed the doctor's advice to adjust the external fixation frame's length daily (approximately 1 mm of bone transportation per day) and attended check-ups every two weeks. The postoperative biopsy results indicated a non-ossifying fibroma combined with an arteriovenous malformation bone cyst.



Figure 1 Preoperative images. A: Anterior-posterior X-ray image of the right knee; B: Lateral X-ray view of the right knee; C: Computed tomography (CT) 3-dimensional reconstruction of the right knee; D: Sagittal plane CT image of the right knee; E: Coronal plane CT of the right knee; F: Sagittal plane magnetic resonance imaging image of the right knee; G: Coronal plane CT image of the right knee.

OUTCOME AND FOLLOW-UP

The X-ray also reveals that the patient's right lower limb is approximately 1cm longer than the left lower limb. The external appearance is entirely normal, and both the bone formation at the cut end and the union at the meeting point of the bones show excellent healing (Figure 4).

DISCUSSION

The Ilizarov technique, as a regenerative tissue technology, continues to play an indispensable role in treating bone defects[1]. ABC is a benign lytic bone lesion typically occurring at the metaphysis of long bones. Its biological characteristics include aggressive tumor growth, local solid invasiveness, and a high rate of postoperative recurrence[2]. According to the onset pattern, it is classified into secondary and primary forms. The lesion comprises numerous blood-filled channels and solid regions, often found in the pelvis, appendages of the spine, and metaphysis of long bones[3]. However, it can occasionally affect shorter bones, such as the hands and feet. Clinical presentations, including local skin warmth, pain, and swelling, are often nonspecific. Patients may occasionally seek medical attention due to pathological fractures[4]. ABC is a benign expansile and osteolytic bone tumor. After complete excision, bone grafting is the main treatment for the primary ABC. When the tumor volume is large, inevitable bone defects occur after excision. The Ilizarov external fixation technique, based on the tension-stress principle, was initially developed in the former Soviet Union and has been widely adopted by physicians. It involves the gradual and steady pulling and fixation of the bone ends using an external fixator after surgically cutting the proximal or distal bone at the lesion site. This process stimulates bone tissue metabolism, activates the body's intrinsic repair mechanisms, promotes bone regeneration, and facilitates the gradual growth of surrounding nerves, tendons, connective tissues, and skin under the traction stimulus[5]. Since approximately 70% of ABC cases occur in children, protecting the growth plate becomes essential during surgery due to the unique nature of children's growth and development. In this case, our hospital employed the Ilizarov technique as an adjunctive treatment, yielding satisfactory results. The follow-up revealed ossification in the affected limb, and the child's growth and development remained largely unaffected. Both the patient and their family expressed a high satisfaction. This case report aims to contribute valuable insights for the future treatment of similar conditions.

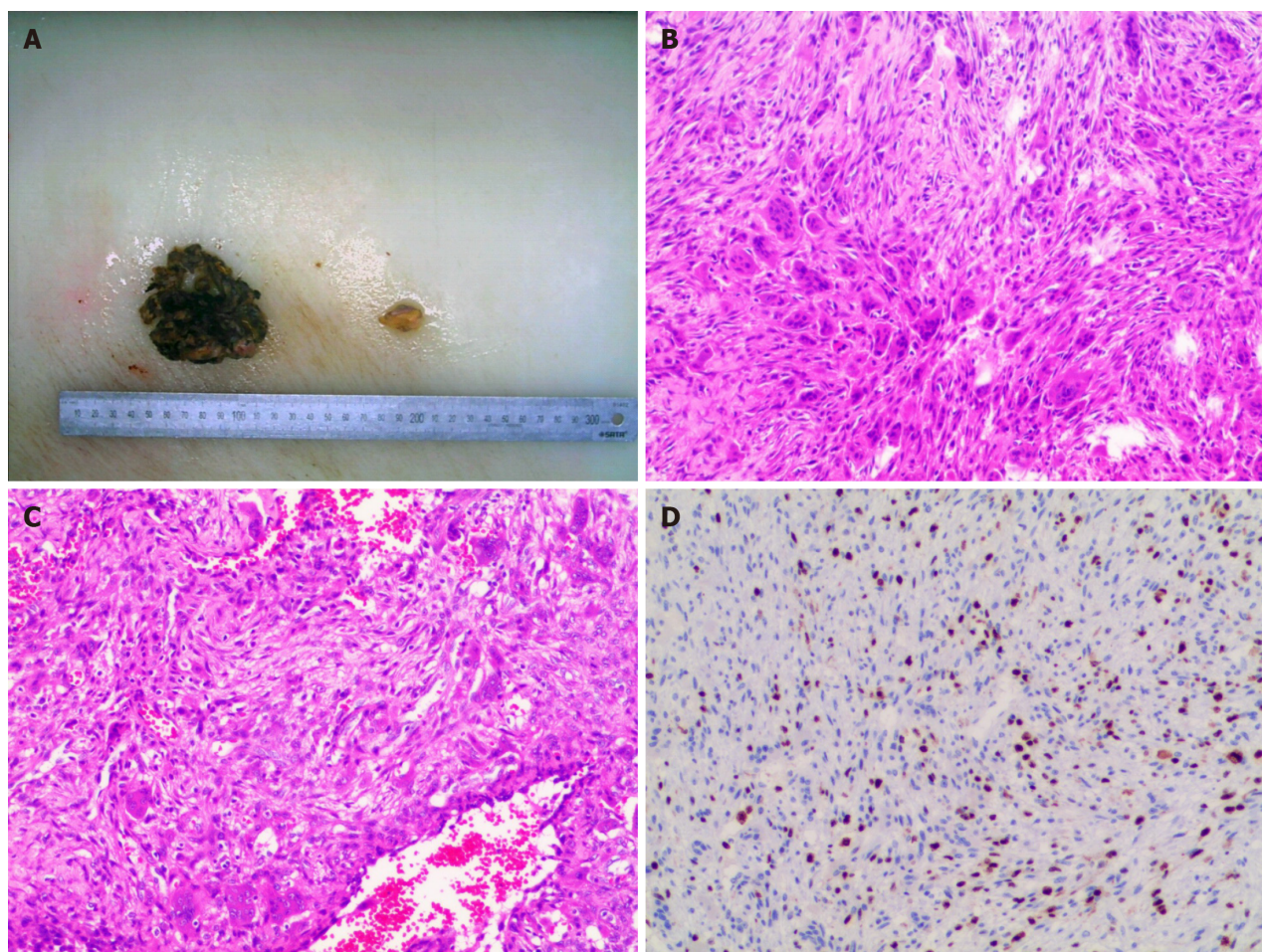


Figure 2 Pathological photos. A: Appearance of the removed lesion; B-D: Microscopic view of the stained lesion.

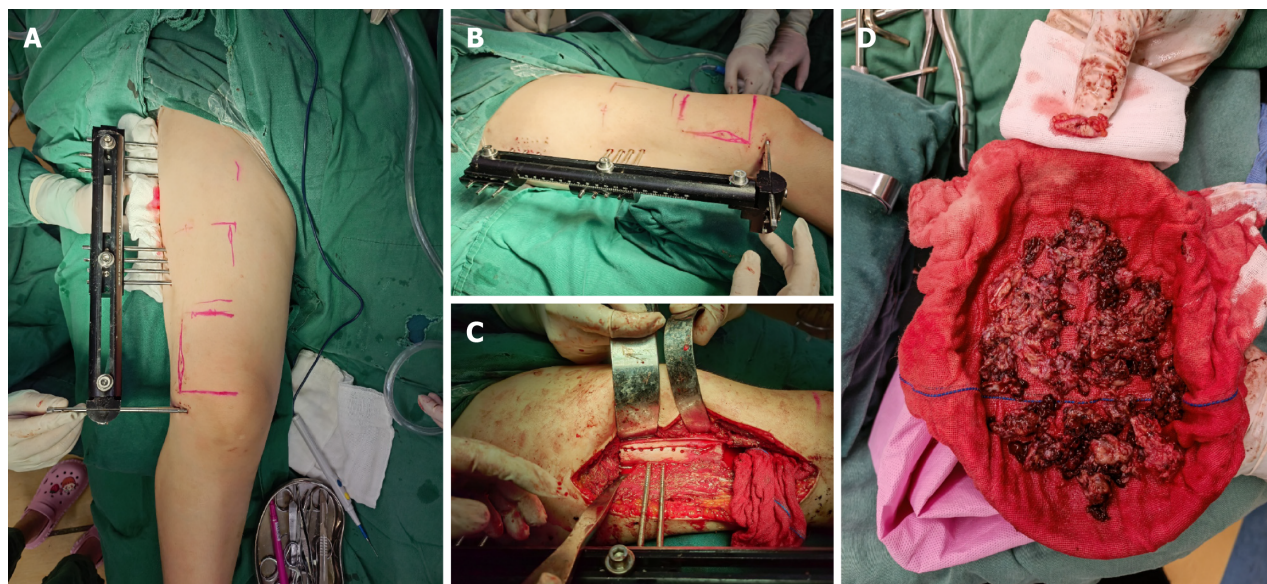


Figure 3 Intraoperative pictures. A and B: Pictures after the external fixation frame; C: Picture of resection of tumor; D: The picture of extracted tumor tissue.

CONCLUSION

Ilizarov technique, as a regenerative tissue technology, continues to play an irreplaceable role in the treatment of bone defects[5]. We present a unique case of ABC successfully treated with Ilizarov technique, which minimize harm to the patient. The two year's follow-up results were satisfactory. Doctors should be aware of the advantage of Ilizarov

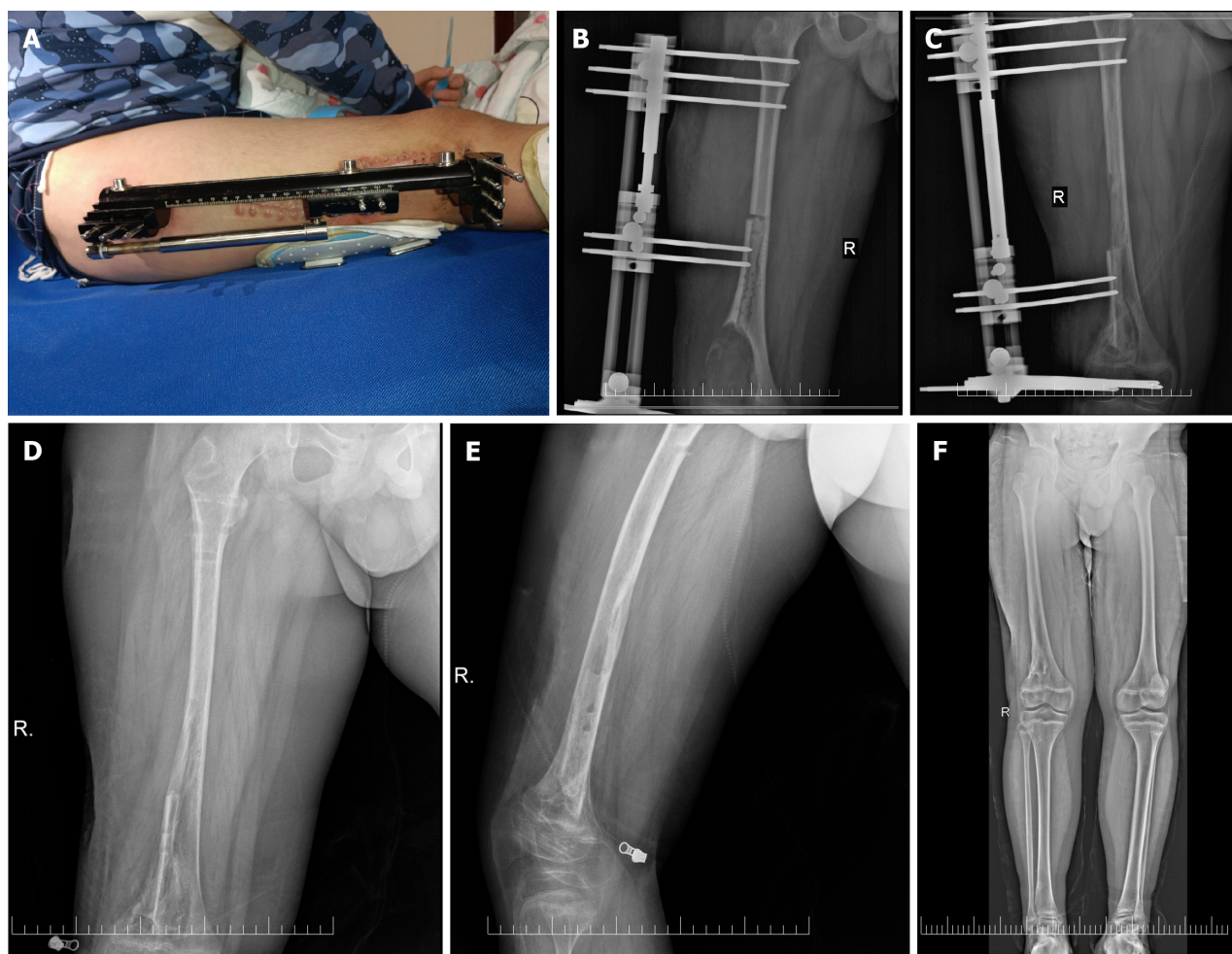


Figure 4 Postoperative follow-up photos. A: Photo at review; B: Anterior-posterior X-ray image of the right knee four days after surgery; C: Anterior-posterior X-ray image of the right knee five months after surgery; D: Anterior-posterior X-ray image of the right knee after remove the external fixator; E: Lateral X-ray image of the right knee after remove the external fixator; F: Anterior-posterior X-ray image of the lower limbs.

technique, and maximize its strength in similar cases.

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FOOTNOTES

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