

Treatment of solitary bone cysts at the proximal end of the femur - 10-year experience

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Abstract— **INTRODUCTION:** Solitary bone cysts are diagnosed in almost every bone, with the humerus and femur occupying almost 70% of cases. In 80% of patients, fracture is the first symptom.

The aim of this study is to share and analyze our results of surgical treatment of solitary bone cyst localized in the proximal femur.

MATERIALS AND METHODS: Ten children with a solitary bone cyst at the proximal femur were operated and followed up in our hospital from 2011 to 2021. LCP Ped hip plate 130⁰ was used in 9 of the patients, and one of them was treated with intralesional Cortizone injections. Three years later, the bone lesion recurred and the cavity was filled with a synthetic bone substitute.

RESULTS: In nine of the ten patients treated with LCP Ped hip plate 130⁰, the mean preoperative NSA of 112.86° was corrected to a sustained postoperative NSA of 138.14°. In two of the cases fixed with LCP Ped hip plate 130⁰ 5.0mm there was a limb length discrepancy which necessitated contralateral distal femoral epiphysiodesis.

CONCLUSION: Solitary bone cyst in the proximal femur needs special attention and each case should be evaluated individually.

Synthesis with the LCP pediatric hip plate in pathologic fractures allows stability, early and complete consolidation with healing of the cyst, anatomic repair of the proximal femur with low risk of avascular necrosis, and achievement of optimal functional results.

Keywords— Solitary bone cyst, proximal femur, operative treatment

1. Introduction

Simple bone cyst (synonym - solitary bone cyst, SBC) is included by WHO, 2013, in the group of tumors of indeterminate neoplastic nature, in the subgroup of benign tumors. It is unicameral, located centrally in the bone. The neoplasm is expansively growing, osteolytic, without periosteal reaction, except for tumors complicated with the common for simple cyst-pathological fracture (70%).

The bone cyst was first recognized by Rudolf Virchow in 1858, who found it in the humerus at autopsy. A solitary bone cyst is defined as an atrophic degenerative osteolytic process consisting of a cavity covered by a membrane and filled with fluid.⁸

Sonnenberg (1879) and Schlange (1887) were the authors who first reported cases of cyst of traumatic origin in adolescents.^{2,5}

The highest incidence of these cysts is between 5 and 15 years of age⁸ and 50% of proximal femoral lesions are over 17 years of age and reach up to 54 years of age.²⁶

Solitary bone cysts are diagnosed in almost every bone, as the humerus and femur are affected in almost 70% of cases.³

These bone cysts are the most common cause of pathological fractures in childhood³⁰, and in 80% of patients, the fracture is the first symptom.²⁷

The first most common localization of this type of fracture is the proximal humerus, and the second is the proximal femur.⁷

The treatment of a solitary bone cyst continues to evolve over time. Current methods include injection of biologic and drug agents, decompression, and combined surgical techniques. The goal of treatment is to prevent or control pathologic fracture, promote healing of the cyst, and prevent cyst recurrence and refracture. The choice of treatment is individual to each patient based on clinical and radiological characteristics. The purpose of this study is to describe our experience at the University Hospital of Orthopaedics Prof. Dr. B.Boychev" Sofia, Bulgaria with the results of the surgical treatment of the solitary bone cyst affecting the proximal femur.

2. Materials and methods.

Ten children with a solitary bone cyst in the proximal femur were operated and followed in our hospital between 2011 and 2021. The diagnosis was made by radiological examination in two projections as well as by CT scan. During surgery, biopsies were obtained from the cystic lesions, therefore confirming the initial diagnosis. Eight of the ten children were boys (80%) and two were girls (20%). The mean age of the boys was 11.88 ± 4.12 years and that of the girls was 11.5 ± 2.5 years. In seven of the patients (6 boys and 1 girl), fracture was the first symptom of the presence of the bone lesion, while in the remaining three patients (2 boys and 1 girl), the bone lesion was incidentally detected on radiographs due to complaints of hip pain. According to the Delbet-Colonna classification, four of the fractures were type IV-intertrochanteric fractures and three were type III-basicevical fractures. According to the AO classification, one of the fractures is a complete transtrochanteric multifragmentary fracture (31-M/3.2.III), three are complete transtrochanteric simple fractures (31-M/3.1.III), one is a complete basicevical multifragmentary fracture (31-M/3.2.II), and two are complete basicevical simple fractures (31-M/3.1.II).

In three of the cases, the bone lesion was diagnosed on native radiographs due to complaints of pain, claudication, decreased range of motion in the hip and hypotrophy of the m. quadriceps femoris of the affected limb.

In the remaining 7 patients, pathological fracture was the first symptom. **tabl.1**

Surgical treatment was performed in all patients. In 1 case, the diagnosed solitary bone cyst was located basicevically. Treatment was applied by triple intralesional injection of cortisone under X-ray control with an interval of 4 to 6 weeks between each application. Three years later, at a follow-up examination, the cyst was found to have

recurred, which required surgery and filling of the cavity with a synthetic bone substitute (SBS). **Fig. 1**

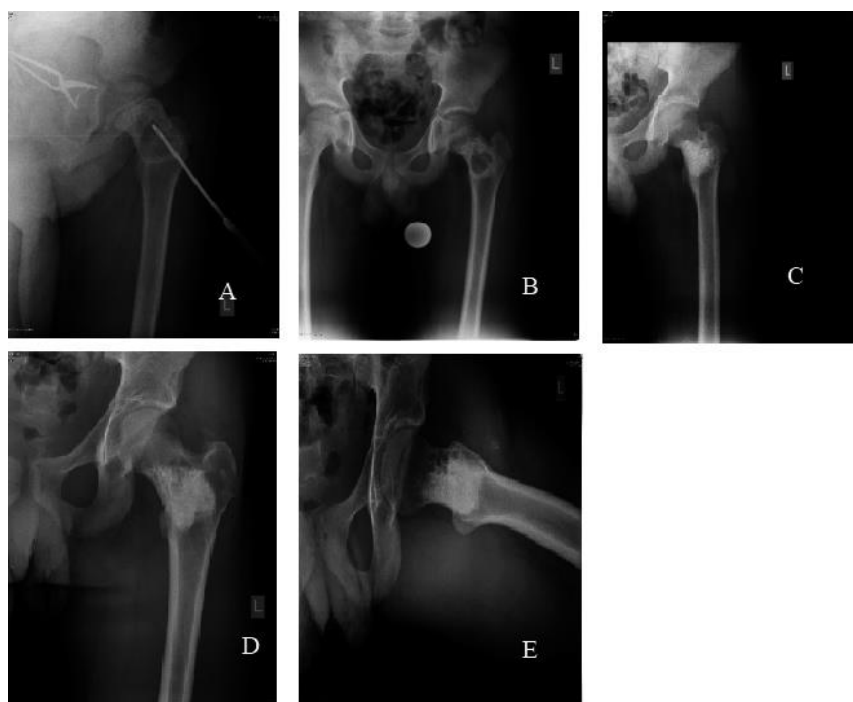


Figure 1. A) Intraoperative X-ray- Cortisone injection; B) Postoperative X-ray 3 years after Cortisone treatment; C) Postoperative X-ray after filling with SBS; D) X-ray AP - 9 years after SBS; E) Profile X-ray- 9 years after SBS

Table 1.

№	пол	години	страна	симптоми	локализация на лезията	локализация на фрактурата	разместване	лечение	усложнения	проследяване в месеци
1	M	10г.	Д	болка, накуцване	интер-, субтрохантерно	интер-, субтрохантерно	разместена	1. кортизон; 2. СКЗ	рецидив	120
2	M	9г.	Л	патологична ф-ра	базиларно, интертрохан	базиларно-мултифрагм	разместена	PCOM	епифизиодеза	31
3	M	16г.	Д	патологична ф-ра	интертрохантерно	интертрохантерна	разместена	PCOM	няма	34
4	M	12г.	Д	болка, слабост в беда	шийка	интертрохантерна	разместена	PCOM + СКЗ	няма	13
5	Ж	14г.	Л	болка, накуцване	интертрохантерно	интертрохантерна	разместена	PCOM + СКЗ	няма	51
6	M	11г.	Д	патологична ф-ра	базиларно, интертрохан	интертрохантерна-мултифрагм	разместена	PCOM	епифизиодеза	36
7	M	16г.	Д	патологична ф-ра	интер-, субтрохантерно	интертрохантерна	неразместена	PCOM	няма	44
8	M	14г.	Д	патологична ф-ра	шийка, интертрохантерно	базиларна	неразместена	PCOM	няма	36
9	Ж	9г.	Л	патологична ф-ра	интертрохантерно	интертрохантерна	разместена	PCOM + СКЗ	няма	10
10	M	7г.	Д	патологична ф-ра	базиларно, интертрохан	базиларна	разместена	PCOM	няма	42
№	sex	age	side	symptoms	Location of the lesion	Location of the fracture	displacement	Treatment	complications	Follow up month
1	M	10y.	R	Pain, limp	inter-, subtrochanteric	inter-, subtrochanteric		1. cortisone; 2. SBS	Recurrence	120
2	M	9y	L	Pathological fracture	basilcervical, intertrochanteric	basilcervical-multifragmentary	Displaced	RSOM	Epiphysiodesis	31
3	M	16y	R	Pathological fracture	Intertrochanteric	intertrochanteric	Displaced	RSOM	No	34
4	M	12y	R	Pain, limp	neck	intertrochanteric		RSOM+ SBS	No	13
5	F	14y	L	Pain, limp	Intertrochanteric	intertrochanteric		RSOM+ SBS	No	51
6	M	11y	R	Pathological fracture	basilcervical, intertrochanteric	intertrochanteric-multifragmentz	Displaced	RSOM	Epiphysiodesis	36
7	M	16y	R	Pathological fracture	inter-, subtrochanteric	intertrochanteric	Undisplaced	RSOM	No	44
8	M	14y	R	Pathological fracture	neck, intertrochanteric	basilcervical	Undisplaced	RSOM	No	36
9	F	9y	L	Pathological fracture	Intertrochanteric	intertrochanteric	Displaced	RSOM+ SBS	No	10
10	M	7y	R	Pathological fracture	basilcervical, intertrochanteric	basilcervical	Displaced	RSOM	No	42

The remaining 9 cases (7 cases of pathologic fractures and 2 cases- risk of fracture) were stabilized with LCP Ped. Hip plate 130⁰.

Operative technique: the patient was placed in lateral position and fixed stably with hip holders. It is operated under X-ray control. The operative technique includes lateral and anterolateral approach in the intertrochanteric area. In three cases, Z-capsulotomy was performed using the Ganz method.¹²

The walls of the pathological cysts were curetted and material was taken for histological verification. The operative wound was washed with isotonic solution to remove free microfragments. In multifragmentary fractures, the particles that are attached to the periosteum are not removed. Repositioning is achieved by careful traction, manipulation of the limb, and by direct insertion using hook traction in the direction of the femoral neck. Temporary stabilization is achieved using 2-3 K-wires. Fixation with the LCP Ped. hip plate 130⁰ is achieved by strictly following the manufacturer's and AO Surgery Reference steps. Six 5.0mm and three 3.5mm plates were used intraoperatively with the size depending on each patient's body mass index. A locking screw was placed through the third plate hole instead of a compressive one. In seven of the nine children, one or two of the proximal screws passed through the growth zone for additional stabilization. Additional fixation with one cortical screw was performed in the patients with the multifragmentary fractures. Definitive radiographs in two projections were performed at the end of each operation. **Fig.2**



Figure 2. A,B) Preoperative X-ray of multifragmentary displaced fracture; C, D) Intraoperative X-ray of the stabilized fracture with LCP Ped hip plate 1300; E,F) Postoperative X-ray - 3 years after surgery

The postoperative period was uneventful, with early rehabilitation as hip flexion was allowed up to 30-40° in all patients. No additional external stabilization was required in any patient. Partial weight-bearing of the operated limb using two crutches was allowed 6 weeks after surgery, and full weight-bearing at postoperative week 12 after radiological evidence of consolidation.

Clinical and radiological controls were performed at 6, 12 and 24 weeks and after that- at 12 months postoperatively.

3. Results

The mean follow-up after surgical treatment was 42 months (range 10-120months). In the first case, 6 months after the implantation of the synthetic graft, a complete bone remodeling was registered.

In the remaining patients, according to Cappana's classification, 8 of the 9 patients showed complete spontaneous repair of the solitary cyst. At the last follow-up, the repairs were classified as grade 1. One cyst was classified as grade 2, indicating a residual bone lesion positive radiologically at the last follow-up. In this patient, the cystic index was estimated to be 2.27 at the 36th postoperative month. Due reparation in all other patients, cystic index could not be determined.

Postoperative correction of the varus fracture deformity was achieved in all 7 children. (Tabl. 2).

Table 2: Changes in CDA in degrees – preoperatively, postoperatively, and final follow-up of both the fractured side and healthy side.

Case №	CDA (°) Pre-op	CDA (°) Intra-op	CDA (°) healthy side	CDA (°) at final follow-up
1	100	130	135	137
2	113	138	140	140
3	111	125	132	126
4	118	158	148	158
5	120	135	134	136
6	113	137	135	132
7	115	136	138	138
Mean	112,86	137	137,42	138,14

The cervical-diaphyseal angle (CDA) of 112.86° preoperatively was corrected to 137°. The achieved correction was permanent and the mean value of the final follow-up CDA was 138.14°, while there was no statistically significant difference compared with intraoperative. The surgical technique achieved an intraoperative correction of the CDA statistically equal to the CDA of the healthy side. In 7 of the 9 patients who were stabilized with the LCP Ped Hip Plate 1300, there was no growth disturbance of the

operated femur. Postoperatively, 2 of the children showed clinically significant differences in the length of both lower limbs. In both children, 5.0 mm LCP hip plates were used. Contralateral distal femoral epiphysiodesis was performed to correct the limb lengths using the Mitaizeau method. There was no difference in limb lengths in all patients in whom 3.5 mm plates were used and in 2 of the cases with 5.0 mm plates, and distal migration of the proximal screws from the growth zone over time was observed.

4. Discussion

Consensus on a definitive treatment, targeting the pathogenesis of the solitary bone cyst, is still absent.⁴¹

A number of authors argue, that the probability of spontaneous healing of the cyst after pathological fracture is very low, probably less than 5%.^{1,4,11,26}

The treatment of solitary bone cysts continues to evolve over time. The therapeutic plan should be individualized for each patient based on clinical and radiological features.

Dormans et al. accepted the following as risk factors for pathologic fracture due to a solitary bone cyst: 1) a cyst with a transverse diameter that is > 85% of the diameter of the affected bone; 2) a cyst wall that is < 0.5 mm thick.^{4,9,24}

Scaglietti first introduced the technique of treating solitary bone cysts with steroid injections.³⁷

A number of authors have reported recurrence rates of 15% to 88% after 3 corticosteroid applications, including Scaglietti and his team.^{6,15,29,36}

A number of authors have used percutaneous intramedullary decompression, curettage, and calcium phosphate granule implantation as a treatment modality for solitary bone cysts in a number of studies. With all analyses and reports indicating positive results and minimal recurrence rate of the lesion.^{10,13,19,21}

Pathological fractures in the proximal part of the femur play a special role in the treatment of solitary bone cysts because of the complications they can lead to.

A cyst localized in the metaphysis of the femur can cause a pathologic fracture with serious complications such as varus deformity, osteonecrosis, and growth arrest of the proximal part of the bone.^{9,31}

The basicervical and intertrochanteric localization of the fracture creates difficult conditions for the use of elastic intramedullary nails. This technique has proven its therapeutic potential in cases with subtrochanteric and diaphyseal traumatic and pathologic fractures.^{14,33,42}

However, osteosynthesis with TEN of short proximal fracture fragments has a higher complication rate and carries the risk of unplanned revision surgery.^{25,28,38}

There are few case reports in the current literature of other osteosynthesis therapy for pediatric pathologic proximal femoral fractures. Havrůnek reports two children treated with a proximal femoral AO-ASIF angular plate who recovered well without sequelae.¹⁶

Miu A. reported a series of 27 patients with the same pathology.²²

In two patients, intramedullary nailing with two TENs and filling with substitute materials was performed. PFNA and Arex Bone filling was applied in one patient, and eight patients underwent minimally invasive resection-biopsy and filling with a substitute material. One particular case recurred and required osteosynthesis using an external fixator. Dormans and Pill classified pathologic fractures of the proximal femur with UBC into six types based on the location and size of the cyst and the presence or absence of a lateral buttress wall.⁹

They recommend, in addition to curettage and grafting, the use of a pediatric hip screw and lateral plate in cases where the lateral cortex is compromised in skeletally immature hips, in addition to selective postoperative application of a spica cast. Jamshidi has used a proximal locking plate and fibular stem allograft in six fractures in a series of 14 children with UBC.¹⁷

The choice to perform LCP pediatric hip plate osteosynthesis in the given fractures was based on our 15 years of experience applying this type of osteosynthesis in more than 400 proximal femoral osteotomies and on data from the medical literature on its application in osteoporotic and insufficient bone.^{18,20,34,35,39}

Our results demonstrate that the 130° LCP pediatric hip plate allows for intraoperative long-lasting anatomic correction. Follow-up data of the NDA during the follow-up support the preservation of the correction. We recommend early surgical treatment, which allows for reduction of pain symptoms as well as early mobilization.

The technique used is atraumatic and doesn't disrupt epiphyseal growth.^{22,23}

None of the patients in the series developed avascular necrosis. This may be due to the relatively low possibility of its development in basiocervical and intertrochanteric fractures. The protection of the a. circumflexa femoris medialis during surgery and the application of a frontal Z-capsulotomy is another potential factor in the successful prevention of avascular necrosis.

The healing of the bone lesions was uneventful, except in case 1, in which the lesion recurred in the third year after three applications of Cortisone according to the Scaglietti technique, and this required a second operation to fill the defect with SBS. In all other cases there was early callus formation at 6 weeks after surgery, and complete bone consolidation at 24 weeks after surgery. This was related to the older age of the patients as well as the rigidity of fixation and angular stability of the plate-screw system provided by LCP pediatric plates. At final follow-up, complete consolidation was achieved without a single case of nonunion.

No growth plate disruption was observed using the 3.5-mm LCP plates, which was confirmed by the migration of the proximal screws in the distal direction. It can be assumed that with the use of the 5.0 mm LCP plates and the penetration of more than one screw through the physis, there is a potential interruption of femoral growth. We agree with other authors when it comes to observing early epiphyseal closure in pathologic fractures.^{32,40}

Therefore, we recommend radiographic control of the lower extremities in AP projections every six months until growth is complete.

The stability of osteosynthesis allows early verticalization and partial weight bearing. This improves children's functional and emotional status and rapid return to normal social life.

5. Conclusion

Solitary bone cyst of the proximal femur needs special attention as it has unique characteristics and complications. Each case should be evaluated individually.

Synthesis with the LCP pediatric hip plate in pathologic fractures or those that threaten to fracture allows for stability, consolidation, anatomic repair of the proximal femur with low risk of AVN, and optimal functional outcomes. There is a risk of disruption of femoral growth when using 5 mm plates.

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