

Management of unicameral bone cysts by intramedullary flexible nails: a series of 18 children

Vivek Sodhai, Chaitrali Gundawar, Sandeep Patwardhan, Arjun K. Unnam, Parag Sancheti

Sancheti Institute for Orthopaedics and Rehabilitation, Pune, Maharashtra, India

Correspondence to Vivek Sodhai, MBBS, MS, Department of Paediatric Orthopaedics, Sancheti Institute for Orthopaedics and Rehabilitation, Pune, Maharashtra, India, Postal address: 16, Thube Park, Shivaji Nagar, Pune 411005, Maharashtra, India
Tel: 020 2899 9876;
e-mail: vivek.sodhai89@gmail.com

Received: 21-Dec-2023

Revised: 18-Jan-2024

Accepted: 22-Jan-2024

Published: 03-Apr-2024

The Egyptian Orthopaedic Journal 2024, 59:98–102

Introduction

The intracystic injection of methylprednisolone acetate, curettage with bone grafting, osteoinductive treatments employing demineralized bone matrix, and intramedullary fixation with flexible nails are being used to treat unicameral bone cysts (UBC) in children. The purpose of this study was to assess the functional results of elastic stable intramedullary nails for symptomatic UBC with or without a fracture.

Methods

From March 2012 to March 2022, 18 patients with UBC were treated with intramedullary flexible nails. Pathological fractures were present at the cyst site in 6 individuals. 12 patients had discomfort and swelling in the afflicted extremity. Cysts were found in the humerus in 13 (72%) patients and the femur in 5 (28%) cases. The average age of the patient at the time of surgery was 7.8 (6–12 years), and the average follow-up period was 16 months. The Capanna *et al.* criteria were used to do the radiographic evaluation.

Results

According to radiological evaluation by Capanna *et al.*, 5 cysts healed completely (Stage I), 5 cysts healed with residual radiolucent areas visible on radiographs that were less than 3 cm in size (Stage II), and 7 cysts healed with residual radiolucent areas that were visible on radiographs that were larger than 3 cm in size (Stage III). An infection at the surgery site affected one patient. A 12 (60%) patients had their implants removed.

Conclusion

Elastic stable intramedullary nailing promotes early stabilization, enables early mobilization, eliminates the need for a plaster cast, and reduces the occurrence of a pathological fracture with early return to functional activity.

Keywords:

curettage, elastic stable intramedullary nailing, pathological fracture, simple bone cyst, unicameral bone cyst

Egypt Orthop J 2024, 59:98–102

© 2024 The Egyptian Orthopaedic Journal

1110-1148

Introduction

Unicameral Bone cysts (UBC) can be treated using the less invasive procedure of elastic stable intramedullary nailing (ESIN). Early stability is made possible, and the cyst is decompressed to promote healing. Particularly in individuals with pathological fractures, elastic nails minimize intracystic pressure by intramedullary decompression, promote healing, and enable early postoperative motion by providing instant stability [1]. The proximal humerus and proximal femur are the two bones most frequently affected [2]. About two-thirds of these cysts are vulnerable to a cortical break. The age of the patient, cortical thinning, pathological fractures in which the cyst did not clear, cyst morphology (cyst index), the percentage of afflicted bone, and proximity to the physis are factors that determine the choice to surgically treat UBCs [3]. Intracystic injections of methylprednisolone acetate, curettage with bone grafting, osteoinductive procedures employing

demineralized bone matrix, and intramedullary fixation to stabilize the bone are all current therapy options [4]. Our study aims to assess the functional results of ESIN in UBC with or without a pathological fracture.

Methods

In this retrospective analysis, 18 kids with UBC of the humerus and femur treated surgically with flexible intramedullary nailing at our institute between March 2012 and 2022 were included. Out of 18, six were girls and 12 were boys.

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

The data was gathered from prior medical records. Parents gave informed consent to participate in the study, and the approval was obtained from the institutional review board. Based on radiographic and clinical criteria, a diagnosis was made. A history of pathologic fracture or the surgeon's estimate of the risk of an upcoming fracture based on the patient's clinical pain history, radiographic findings of UBC, and cortical thinning (cyst index) were both grounds for surgery [5]. It was deemed sufficient for the case to be included if a radiolucent metaphyseal lesion with a distinctive lytic look and cortical thinning was discovered on plain film, particularly in the presence of pathologic fracture or pain. Pain at the cyst site, active cysts, and a cyst index between 3 and 3.5 were required for inclusion in this study. According to Kaelin and MacEwen [6], the cyst index was calculated by dividing the cavity's area at its widest point by the diameter of the bone's diaphysis.

A total of 13 patients had the cyst located in the proximal humerus, while five patients had it in the proximal femur. Six patients had pathological fractures when they arrived. 12 were symptomatic with pain in the affected extremity. All patients were followed for a minimum of two years. The cyst's healing was evaluated using Cappanna's criteria, namely excellent: the cyst is completely eliminated; residual defect: one or more static cyst-like areas with good bone strength (cortical thickness) restoration, recurrence: the cyst recurs and continues to grow, necessitating further surgery.

We followed the surgical technique of retrograde ESIN described by Metaizeau *et al.* [7] The distal metaphyseal area was used as an entry point through a minimally invasive technique. Flexible intramedullary nails were always present before being retrogradely placed after reduction of the pathologic fractures. Depending on the size of the bone's medullary canal, the nail's size is selected. The handle is covered by the nail, which is then rotated gently to release the medullary canal. To promote blood flow from the medullary cavity to the cyst cavity and promote healing, the cyst wall is curetted with the tip of a nail. The stability of the fixation was examined under an image intensifier before the wound was closed. The cortex of the bone was left with around 1 cm in it after the nails were clipped flush to the bone.

Postoperative period: On the first postoperative day following surgery, therapy for humeral lesions that were nailed was begun. Nonweight bearing walking was initiated in the event of a pathologic femur fracture during the hospital stay and continued for one month before being gradually introduced after radiological healing. The orthopaedic outpatient clinic performed radiographic follow-up. After surgery, radiographs

were collected on postoperative day 1, 4 weeks later, 3 months later, 6 months later, and 1 year later. After that, it was done yearly to check for cyst regression. The following Cappanna *et al.* described criteria were employed by us to categorise the bone cyst healing: Complete cyst filling with bone, partial cyst filling with thickening of the cyst wall and tiny lucencies of less than 3 cm, recurrence of the cyst with lucencies of more than 3 cm, and no reaction from the cyst are the possible outcomes. The removal of the implants went smoothly in 12 individuals.

Results

There were 11 patients with proximal humerus cysts and two patients with diaphysis cysts. The subtrochanteric area was the site of the femoral cysts (5 cases).

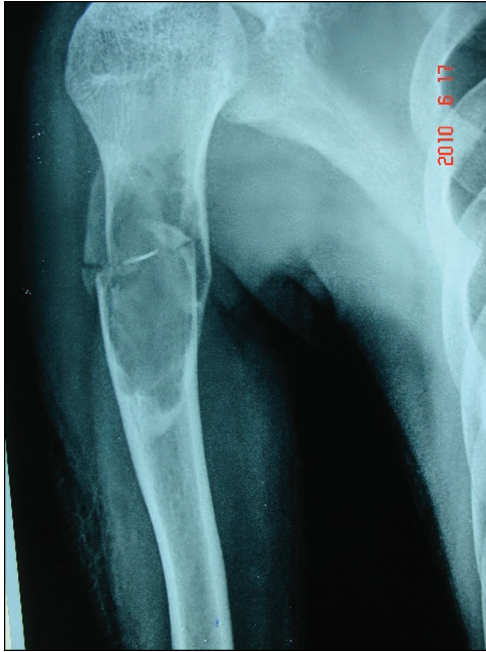
Cysts were identified in 6 cases when a pathologic fracture occurred, and 12 lesions were found on radiographs taken to diagnose local discomfort or sprains. Nine days on average passed between the diagnosis and the operation. After surgery, the typical follow-up was 24 months (range 12–38). UBC incidence was found to be greater in boys (66.6%) than in females (33.3%), with the age group of 7–11 years having the highest incidence.

UBC is more frequent in 13 instances involving the humerus (81.11%) than in 5 cases involving the femur (8.89%). Metaphysis was shown to have a higher prevalence of UBC. Six (33.3%) individuals were seen when a pathological fracture occurred.

The classification of Cappanna states that five UBC recovered entirely in under 14 months. One recurrence was discovered 18 months after the initial treatment while the nail was still in place, and five lesions were graded as 2, seven as 3, and one as grade 3. The patient with recurrence has been monitored clinically and radiographically. At the time of follow-up, none of the patients expressed any pain at the surgical site. After a mean of 21 months postoperatively, implants were removed in 12 (66.6%) of the patients.

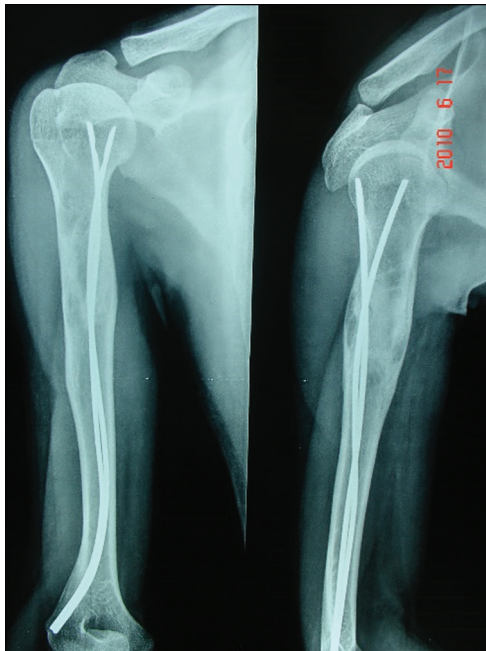
Final radiographs in the sagittal and frontal planes showed no deformation larger than 5 degrees. The incidence of complications was extremely low, and one instance involved a superficial infection at the nail entry site that was managed locally and with oral antibiotics. All patients' postoperative bone growth was confirmed to be normal in all cases. No patient had experienced a re-fracture or a new pathologic cortical lesion up until the most recent follow-up. Figure 1 Pathological fracture with classical 'fallen leaf sign' secondary to

Figure 1



Pathological fracture with classical 'fallen leaf sign' secondary to Unicameral bone cyst in 13-year-old child.

Figure 2



Radiograph at 12 months showing completely healed lesion.

UBC in 13-year-old child. Figure 2 Radiograph at 12 months showing completely healed lesion. Table 1 shows the demographic data of all 18 children.

Discussion

The current recommendations for treating UBC are as follows: 1. Observation, 2. Cysts in the humerus with

an index of less than 4, 3. Cysts in the femur with an index of less than 3.5, and 4. Stronger consideration was seen to be required for surgical intervention when one of these thresholds was exceeded.

To treat UBCs, Scaglietti *et al.* [8] employed intralesional steroid injection for the first time between 1974 and 1975. They investigated 82 cases of bone cysts using the cortisone injection approach and tracked the patients for one to three years. 90% of patients saw positive benefits, but the biggest drawback was that they required several doses. Ahmet *et al.* compared the care of a pathological fracture in a UBC between steroid injection and conservative treatment. When these patients were evaluated, there was no distinction between the two groups in terms of the cysts' ability to heal [9]. Another study by Frank *et al.* compared the effects of intramedullary nailing with or without steroid instillation on 135 individuals with UBC. Intralesional steroids were thought to be a reliable kind of treatment because patients who received them had a lower failure rate [10]. In order to examine the long-term effects of steroid treatment for UBC, V Pavone and colleagues carried out a retrospective analysis in 2014 on 23 UBC patients treated with repeated methylprednisolone injections and followed them up till adolescence. At the conclusion of the follow-up, 82% of the 23 patients shown an overall satisfactory response, whereas 17% displayed a refracture [11]. The high rate of recurrence, pathologic fractures during treatment, and steroid-caused avascular necrosis due to the increased systemic absorption of steroids are therefore known side effects of steroid injections for UBCs. Three factors: the number of internal cavities, cyst volume, and lesion activity were primarily responsible for a cyst's continued existence following methylprednisolone injection [6].

In recent years (75–100%) the use of intramedullary nails has produced excellent outcomes [12]. When compared with the outcomes of drainage screws, curettage, and bone grafting, intramedullary nailing was anticipated by Blaz Mavcic and colleagues to have a lower probability of postoperative UBC recurrence. The postoperative fracture rate, morbidity, or the final radiological result did not differ across the therapy groups [13]. Ke-Xue Zhang and colleagues studied the effectiveness of the elastic stable intramedullary nail, the injection of autologous bone marrow, and the combination of both in the treatment of bone cyst in children. In comparison to autologous bone marrow transplant and combination therapy, elastic stable intramedullary nail demonstrated a greater effective rate and cure rate. It also experiences the fewest hospital stays [14]. After treating the UBCs with internal fixation, fewer subsequent operations were needed, and it took less time for patients to resume their

Table 1 Demographic data

Sr no	Age	Sex	Bone affected	Region of bone	Capanna's grade	Follow-up period	Pain	ROM	Complication	Implant removal	Pathological fracture
1	12	F	Rt Humerus	Diaphysis	2	24	No	Full	No	done	No
2	08	M	Rt femur	Metaphysis	2	18	No	Full	No	done	No
3	09	F	Rt femur	Metaphysis	2	18	No	Full	No	done	No
4	07	M	Lt humerus	Metaphysis	3	10	No	Full	No	not done	No
5	12	M	Rt humerus	Diaphysis	1	14	No	Full	No	not done	Present
6	08	F	Rt femur	Metaphysis	3	16	No	Full	No	done	No
7	07	F	Lt humerus	Metaphysis	3	14	No	Full	No	done	No
8	06	M	Lt humerus	Metaphysis	3	12	No	Full	No	not done	No
9	07	M	Lt humerus	Metaphysis	1	18	No	Full	No	done	Present
10	08	M	Lt humerus	Metaphysis	4	24	No	Full	No	done	Present
11	11	F	Rt Humerus	Metaphysis	2	16	No	Full	No	done	No
12	08	M	Lt femur	Metaphysis	2	10	No	Full	No	not done	Present
13	09	M	Lt humerus	Metaphysis	3	16	No	Full	No	done	No
14	11	F	Lt humerus	Metaphysis	3	18	No	Full	No	done	No
15	09	M	Lt humerus	Metaphysis	1	12	No	Full	No	not done	No
16	10	M	Lt femur	Metaphysis	3	18	No	Full	Yes	done	No
17	07	M	Lt humerus	Metaphysis	1	18	No	Full	No	done	No
18	08	M	Lt humerus	Metaphysis	1	12	No	Full	No	not done	No

regular activities, according to William *et al.* Therefore, we think that the most crucial aspect of surgery is establishing contact between the cyst and the medullary canal. In a related study by Roposch *et al.* [12], 32 patients with a UBC chose flexible intramedullary nailing as their preferred course of treatment. Their findings were successful, and the healing time varied from three to 105 months. Fourteen cysts had fully recovered, and 16 had recovered with lingering radiolucent patches that could still be seen on radiographs. Two cysts that had healed with residual radiolucency showed recurrence, but no significant consequences were noticed. Therefore, we think that utilising this technique has the benefits of instant stabilisation, ongoing depression, and minimally invasive surgery. The hospital stays and return to normal activity, however, are both positively impacted.

Open treatments have had success rates ranging from 60 to 70%. The cyst has returned in the remaining 30–40% of patients, necessitating further open surgical procedures [15]. Infection, coxa vara, physical injury, epiphyseal arrest and shortening of the limb, higher intraoperative blood loss, intraoperative fractures, and a prolonged period of postoperative immobilisation are additional problems associated with aggressive surgical approaches. According to Campanacci and colleagues a growth plate lesion during surgery may be to blame for the 14% retardation of longitudinal growth and limb-length disparity, rather than a cyst next to the physics [16].

The UBC can be treated by ESIN, which can be done using a secure and standardised method. Internal stabilisation enables early weight bearing on the injured

section and provides rapid mechanical stability while the cyst is decompressed. The healing rates shown in our study match those found in the literature. Once the intramedullary fracture was stabilised, there was no sign of refracture.

Conclusion

ESIN promotes early stabilisation, enables early mobilisation, eliminates the need for a plaster cast, and reduces the occurrence of a pathological fracture with early return to functional activity [11–13].

Limitations of the study

A retrospective series, small sample size and short duration of follow-up were the limitations in our study.

Acknowledgments

None.

Financial support and sponsorship

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Conflicts of interest

There are no conflicts of interest.

References

- Masquijo JJ, Baroni E, Miscione H. Continuous decompression with intramedullary nailing for the treatment of unicameral bone cysts. *J Child Orthop* 2008; 2: 279-283.
- Noordin S, Allana S, Umer M, Jamil M, Hilal K, Uddin N. Unicameral bone cysts: Current concepts. *Ann Med Surg (Lond)* 2018; 34:43–49.
- Farr S, Balacó IMS, Martínez-Alvarez S, Hahne J, Bae DS. Current Trends and Variations in the Treatment of Unicameral Bone Cysts of the

- Humerus: A Survey of EPOS and POSNA Members. *Journal of Pediatric Orthopaedics* 2020; 40:e68–e76.
4. Bukva B, Vrgoč G, Abramović D, Dučić S, Brkić I, Čengić T. Treatment of unicameral bone cysts in children: a comparative study. *Acta Clin Croat* 2019; 58:403–409.
 5. Ravikanth R, Kamalasekar K. Explanation of radiological signs and fracture indices in a unicameral bone cyst. *Indian J Radiol Imaging* 2019; 29:104–106.
 6. Kaelin AJ, MacEwen GD. Unicameral bone cysts. Natural history and the risk of fracture. *Int Orthop* 1989; 13:275–82.
 7. Metaizeau JP, Lascombes P, Lemelle JL, Finlayson D, Prevot J. Reduction and fixation of displaced radial neck fractures by closed intramedullary pinning. *Journal of Pediatric Orthopedics* 1993; 13: 355–360.
 8. Scaglietti O, Marchetti PG, Bartolozzi P. Final results obtained in the treatment of bone cysts with methylprednisolone acetate (depo-medrol) and a discussion of results achieved in other bone lesions. *Clin Orthop Relat Res* 1982; 165:33–42.
 9. Hashemi-Nejad A, Cole WG. Incomplete healing of simple bone cysts after steroid injections. *J Bone Joint Surg Br* 1997; 79:727–730.
 10. Traub F, Eberhardt O, Fernandez FF, Wirth T. Solitary bone cyst: a comparison of treatment options with special reference to their long term outcome. *BMC Musculoskelet Disord* 2016 17, 162.
 11. Pavone V, Caff G, Di Silvestri C, Avondo S, Sessa G. Steroid injections in the treatment of humeral unicameral bone cysts: long-term follow-up and review of the literature. *Eur J Orthop Surg Traumatol* 24, 497–503 (2014). <https://doi.org/10.1007/s00590-013-1211-4>
 12. Roposch A, Saraph V, Linhart WE. Flexible Intramedullary Nailing for the Treatment of Unicameral Bone Cysts in Long Bones*. *The Journal of Bone & Joint Surgery* 2000;82: 1447.
 13. Mavčič B, Saraph V, Gilg MM, Bergovec M, Brecej J, Leithner A. Comparison of three surgical treatment options for unicameral bone cysts in humerus. *J Pediatr Orthop B*. 2019;28:51-56. doi: 10.1097/BPB.0000000000000518.
 14. Zhang KX, Chai W, Zhao JJ, Deng JH, Peng Z, Chen JY. Comparison of three treatment methods for simple bone cyst in children. *BMC Musculoskelet Disord*. 2021;22:73. doi: 10.1186/s12891-020-03933-8.
 15. Lokiec F, Wientroub S. Simple bone cyst: etiology, classification, pathology, and treatment modalities. *J Pediatr Orthop B*. 1998;7:262-73.
 16. Campanacci M, Capanna R, Picci P. Unicameral and aneurysmal bone cysts. *Clin Orthop* 1986;204:25-36.