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Management of Distal Femoral Osseous Sarcomas using Expandable Endoprosthesis

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Introduction

Limb salvage surgery (LSS) is now the preferred treatment for bone sarcomas of the extremities at most institutions.[1,2] Local control in children often necessitates resection of major growth plates; this makes LSS in the skeletally immature patient a challenge because of the need for maintenance of limb length.[3,4] Around 75% of the reconstructions with expandable endoprostheses are performed at the distal femur.[5-10] Because of the vast variety of options for expandable endoprosthesis, reports on their results are highly heterogeneous and those on the use of expandable endoprostheses in specific sites are rather few. [1,2,5,6,8,11-19] The aim of this study is to report our experience on the management of distal femoral osseous sarcomas, using expandable endoprosthesis.

Methods

After obtaining Institutional Review Board's (IRB) approval, a retrospective review was conducted on the patients who received expandable distal femur endoprostheses between January 2005 and September 2010. A total of 264 sarcoma patients were treated, among whom 28 were treated with a distal femur endoprosthetic reconstruction. Of those, eight patients (5 males and 3 females) were treated consecutively, by the senior author, using a second generation expandable endoprosthesis manufactured by Stryker-Howmedica. Data extracted is summarized in Tables 1 and 2. The small number of patients allowed us to report only descriptive statistics.

Results

The average follow-up time was 28 months. All surgical margins were negative. All the patients were alive at latest follow-up and there were no local recurrences. Five patients (62.5%) had undergone a total of 11 lengthening procedures with a mean of 2.2 lengthenings per patient. In these patients, the average total lengthening to date was 4.44 cm (range 1.2 cm- 9.1 cm). The average lengthening per session, per patient was 2.01 cm. There were no failures in lengthening. No cases of loosening, collapse of lengthening mechanism, mechanical failure of implant, and/ or neurovascular damage or amputations were reported. Demographic data is presented in Table 1. Complications and functional outcomes are summarized in Table 2.

Discussion

In the present study, all 8 patients were treated according to the oncology division's protocol with 3-4 cycles of neoadjuvant chemotherapy, after biopsy and definitive immunohistochemical diagnosis, and adjuvant chemotherapy after definitive local control.

All eight patients followed the institutional post-operative physical therapy protocol for distal femur reconstruction. They were placed in a continuous passive motion (CPM) device approximately two weeks postoperatively until they achieved knee flexion of more than 90°. Toe touch weight bearing was maintained for at least 4 weeks following surgery. Two weeks after the surgery, strengthening of the involved knee was initiated with the goal of obtaining knee strength of 4/5 within 8-12 weeks post-operatively.

Prediction of the ultimate LLD at skeletal maturity was measured using the Moseley straight-line graph. In cases where the length discrepancy was greater than 1.5 to 2 cm and knee flexion was at least 90°, endoprosthetic lengthening was performed under general endotracheal anesthesia via two small incisions; the first for releasing the locking mechanism and the second for the lengthening T wrench. Rehabilitation was started on the first post-operative day after each lengthening.

The reconstruction goal is to initially establish equality of extremity length. Dotan et al performed a 2 cm initial osteoplastic lengthening without any complications.[6] In the present study, the average initial osteoplastic lengthening was 1.32 cm without any complications. Further, the initial lengthening was 24 months after initial implantation, in comparison to 15 months reported by Eckardt et al.[8] The authors consider this a safer approach in that it has the advantage of delaying the first lengthening, thus decreasing the overall number of total procedures.

Multiple skip lesions and extensive femoral involvement without interruption merit consideration for total femoral resection, though it is not a complication-free procedure.[3,20] In the present study, case 1 presented with

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Table 1. Demographic and surgical management characteristics of patients who underwent distal femoral reconstruction with an expandable endoprosthesis due to osseous sarcomas.

Patient	Age at initial surgery (years)	Gender	Follow up (months)	Sarcoma type	Localization of prosthesis	Survival at latest follow up	Number of procedures^	Number of Lengthenings	Time to 1° lengthening (months)	Time in between lengthenings (months)	Initial osteoplastic lengthening (cm)	Bone stock (cm)
1	7	M	67	Osteosarcoma	Left	Alive	7	4	24	12 (8-15)	N/A	0
2	10	F	44	Osteosarcoma	Left	Alive	4	3	31	6.5 (6-7)	2	‹1
3	8	F	38	Osteosarcoma	Right	Alive	3	2	17	10	2	11.6
4	10	M	28	Ewing Sarcoma	Right	Alive	2	1	23	0	1	8.8
5*	10	M	7	Osteosarcoma	Right	Alive	1	0	0	0	1.5	16.2
6	8	M	16	Osteosarcoma	Left	Alive	2	1	14	0	0.8	16.5
7	12	M	12	Osteosarcoma	Right	Alive	1	0	0	0	1.5	17.5
8	7	F	12	Osteosarcoma	Right	Alive	1	0	0	0	0.5	11.5
Mean	**9**	**-**	**28**	**-**	**-**	**Alive**	**2.6**	2.2 (Cases 1-4,5)	24	10.4 (Cases 1-3)	1.32	13.68 (Cases 3-8)

*This patient has also a total femur reconstruction in the contralateral limb due to primary osteosarcoma.

^Includes initial implantation of the expandable endoprosthesis, lengthening, and surgical procedures to resolve complications.

Table 2. Complications and functional outcomes of patients who underwent distal femoral reconstruction with an expandable endoprosthesis due to osseous sarcomas.

	Complications				**Functional Outcome**		
Patient	Infection	Knee Contracture	Neuro vascular	Implant issue	ROM (knee)	Functional status	Notes
1	No	**Yes**	No	**Yes ****	115° (-5-120)	No pain / Full weight bearing / No crutches / slight limping	1 month out of hip revision surgery
2	No	**Yes**	No	No	75° (-5-80)	No pain / Toe touch weight bearing with crutches	10 days out of lengthening
3	No	No	No	**Yes *****	100° (0-100)	Limping due to LLD of 1.5-2 cm. / No crutches	Scheduled for lengthening
4	**Yes ***	**Yes**	No	No	70° (-10-80)	Limping due to knee contracture - under intense PT	
5	No	**Yes**	No	No	85° (-5-90)	Walking with a walker - left side toe-touch weight bearing	2 weeks out of left proximal fibula resection due to metastasic osteosarcoma
6	No	No	No	No	110° (0-110)	No pain / slight limping / No crutches	–
7	No	No	No	No	105° (0-105)	No pain / slight limping / No crutches	–
8	No	No	No	No	110° (0-110)	No pain / slight limping / No crutches	–
Mean	1/8=**12.5%**	**50%**	**0%**	**25%**	**97 °**	–	–

*Superficial wound infection.

**Proximal migration of the femoral stem.

***Proximal periprosthetic fracture.

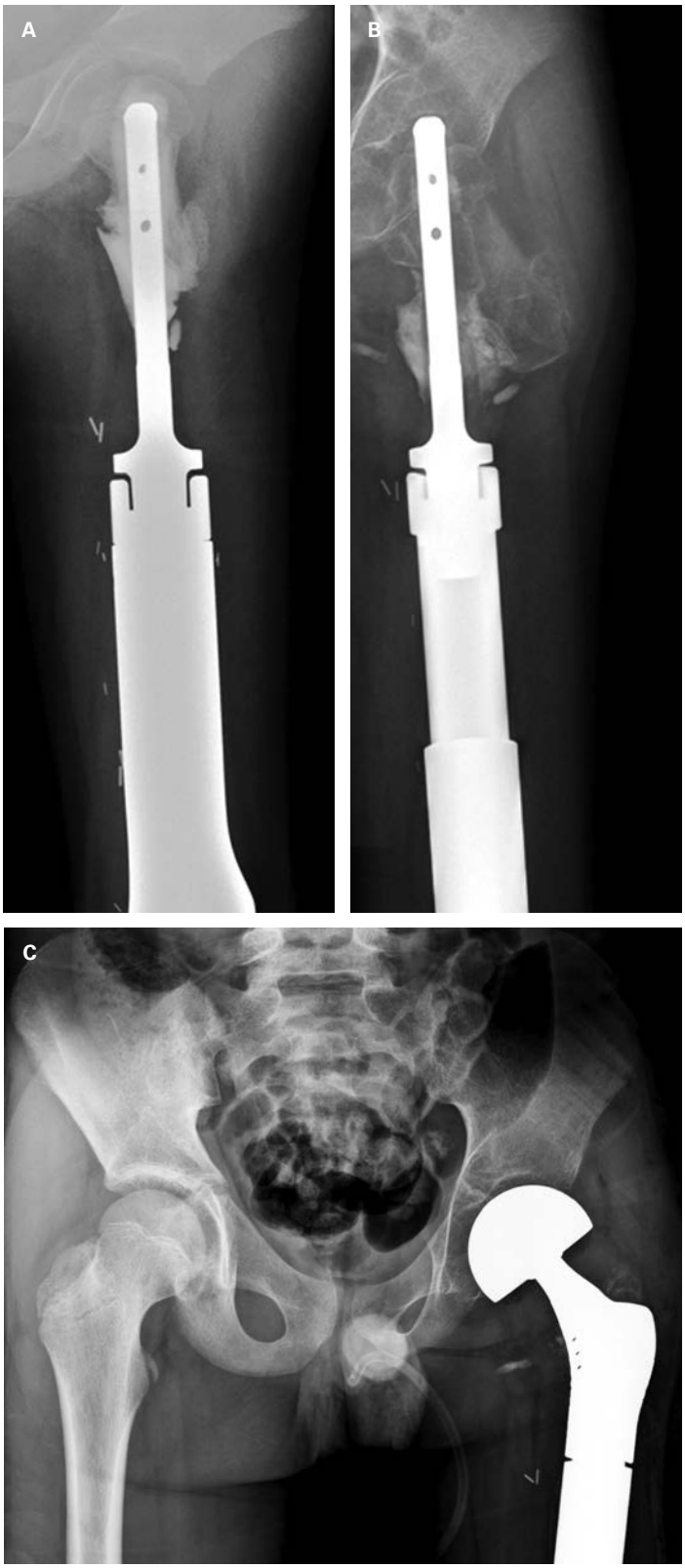

Figure 1. Seven-year-old boy with left distal femoral osteosarcoma undergoing reconstruction with a second generation expandable endoprosthesis (case one). (A) AP plain radiographs view showing distal femoral reconstruction after intertrochanteric osteotomy and verticalization of the proximal femur. (B) AP plain radiograph showing distal femoral reconstruction and proximal migration of the femoral stem- note the area of expansion within the femoral stem. (C) AP pelvis plain radiograph showing proximal femoral bipolar hemiarthroplasty after revision surgery due to proximal migration of the femoral stem.

extensive femoral involvement. The authors believed that attempts should be made to preserve the hip joint so as to maintain the biomechanics. Due to proximal stem migration (Figure 1 A-B), proximal femur bipolar hemiarthroplasty was performed (Figure 1C). In patients with an open triradiate cartilage, whose proximal femur was reconstructed with hemiarthroplasty, a progressive superior and lateral migration of the prosthetic femoral head may occur. To avoid this, acetabular osteotomy, as well as improvement of the abductor-adductor imbalance at the time of surgery may be needed.[21] Also, as subsequent lengthenings can contribute to this issue, contralateral epiphysiodesis may be performed to stop the lengthenings and manage the LLD.

Oncologic complications are not infrequent and are reported in 14% to 71% of the cases.[5,8,17,18] Non-oncologic complications have been reported in 23.5% to 81.8% of the cases in the literature; this discrepancy is mainly due to the usage of different types of devices and lengthening mechanisms. The most common reported complications are aseptic loosening, knee contractures and infection.[8,19,22-26]

There is no consensus on the management of knee flexion contractures. Some authors believe that surgical resection of the pseudocapsule is the right treatment.[4,16] Recent studies show that aggressive physical therapy in the early stages maintains a good range of motion, prevents scar formation and allows subsequent expansions to be achieved with less force on the gearing mechanism.[5,6,17-19] It is possible that, when a patient repeatedly develops contractures after each lengthening, a contralateral epiphysiodesis may become necessary. By doing this, one can manage the LLD and stop the lengthenings that trigger this problem.

The limitations of this study are the small number of patients and short follow up time; however, all the patients were treated by the senior author and with the same type of endoprosthesis, following a standardized protocol of management.

Conclusion

LSS, using expandable endoprosthesis in the distal femur, requires precise surgical planning. Even though the complication rate is relatively high, functional outcome is very good. Early and aggressive rehabilitation is crucial to the management of knee contractures.

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