J Shoulder Elbow Surg (2019) 28, 1654–1657

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Journal of Shoulder and Elbow Surgery

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Aneurysmal bone cysts of the clavicle: a comparison of extended curettage and segmental resection with bone reconstruction

Khodamorad Jamshidi, MD, Amin Karimi, MD, Abolfazl Bagherifard, MD, Alireza Mirzaei, PhD*

Bone and Joint Reconstruction Research Center, Shafa Orthopedic Hospital, Iran University of Medical Sciences, Tehran, Iran

Background: Although curettage of an aneurysmal bone cyst (ABC) of the clavicle has a high rate of local recurrence, segmental resection is often avoided for treatment as it causes functional impairment and shoulder deformity. We evaluated the rate of local recurrence and functional outcomes of extended curettage vs. segmental resection with bone reconstruction for the treatment of clavicular ABC.
Methods: A total of 14 patients with clavicular ABC were studied. Extended curettage and segmental resection with bone reconstruction were done for 6 and 8 patients, respectively. The number of local recurrences and postoperative complications was recorded for each group. The function of the shoulder was assessed using the Constant-Murley score.
Results: The mean age of the patients was 26.2 ± 14.7 years (range, 4-56 years). At a mean follow-up of 60 ± 37.6 months, 2 recurrences developed, both in the curettage group. Two postoperative complications (1 infection and 1 nonunion) were also recorded, both in the segmental resection group. The mean Constant-Murley score was 88.2 ± 3.4 in the extended curettage group and 87.3 ± 2.4 in the segmental resection group ($P = .85$).
Conclusions: Considering the comparable function of the shoulder in curettage and segmental resection with bone reconstruction in clavicular ABC, we recommend the latter approach because of the lower recurrence rate, albeit with a higher rate of potential complications.
Level of Evidence: Level III; Retrospective Cohort Design; Treatment Study

Keywords: Aneurysmal bone cyst; clavicle; extended curettage; segmental resection; bone reconstruction

The aneurysmal bone cyst (ABC) is a benign bone lesion of locally destructive behavior with a high rate of local recurrence. It accounts for 2.5% to 3% of all benign primary bone tumors, and a recurrence rate of 5% to 40% has been reported.[6] The ABC of the clavicle is particularly rare and sparsely described in the literature.[1,4,6,8] As a result, its optimal treatment remains controversial.

Although surgical resection is the most effective approach to prevent recurrence, it may cause shoulder deformity and functional impairment by shortening of the clavicle and disruption of the coracoclavicular ligament. The subsequent morbidity makes this surgical approach

This study was approved by the Institutional Review Board of the Bone and Joint Reconstruction Research Center. Informed consent was obtained from the patients or their parents to use their medical data for publication.

*Reprint requests: Alireza Mirzaei, PhD, Shafa Orthopedic Hospital, Baharestan Square, Tehran, Iran.

E-mail address: mirzaei.ar@iums.ac.ir (A. Mirzaei).

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https://doi.org/10.1016/j.jse.2019.02.012

unpleasant, especially for young patients. For this reason, surgeons generally implement curettage while accepting the higher rate of local recurrence, and a recurrence rate of up to 58% has been reported.[4]

We hypothesized that reconstruction of the clavicle after surgical resection could reduce the postoperative physical deformity and at the same time keep local recurrence at the lowest possible rate. In this study, we compared the results of extended curettage with segmental resection and bone reconstruction in the treatment of clavicular ABC.

Methods

In a retrospective study, the medical files of patients with a confirmed diagnosis of ABC who were surgically treated at our center between 2004 and 2016 were reviewed. Of a total of 192 ABC cases for which the medical records were reviewed, 20 cases of clavicular ABC were identified.

Patients with recurrent ABC of the clavicle (2 cases) and those with a follow-up of <24 months were excluded from the study (1 case). One case of clavicular ABC was secondary to a giant cell tumor and was excluded as well. Patients who were not available for follow-up evaluations were excluded (2 cases). Ultimately, 14 patients with a primary ABC of the clavicle were identified as eligible for this study. Functional outcome was assessed using the Constant-Murley score,[2] whereby a higher score was associated with better function. SPSS software for Windows (version 16; IBM, Armonk, NY, USA) was used for descriptive and inferential analysis of the data. A Mann-Whitney *U* test was used for the comparison of outcome measures between the study groups. A *P* value of $< .05$ was considered statistically significant.

Surgical techniques

Surgical options included extended curettage and bone grafting or segmental resection and bone reconstruction with a fresh frozen fibular allograft. The patients were positioned in a beach chair semisitting position (70°), and a transverse incision was made along the clavicle that was centered over the mass. At first, frozen section analysis was performed to confirm the diagnosis.

Extended curettage was performed for 6 patients (4 cases of lateral, 1 case of middle-third, and 1 case of medial involvement). For extended curettage, an anterior cortical window was made and widened to access the entire tumor area and to avoid the overhanging ridges of the bone. The tumor was then removed with a curet, and the margin was expanded by high-speed burring into the normal cortical bone. Hydrogen peroxidase V10 was used as the chemical adjuvant therapy for better visualization of the cavity. Subsequently, the cavity was filled with fresh frozen cancellous allograft (Fig. 1).

Segmental resection with bone reconstruction was performed for 8 patients (6 cases of lateral and 2 cases of middle-third involvement). For segmental resection, a plane was developed between the mass and adjacent tissues, and the lesion was resected marginally. In the lateral end of the clavicle, we saved the articular surface and burred down from the cancellous bone to the subchondral bone. The fresh frozen fibular allograft was sized to match the defect and fixed to the residual clavicle across the acromioclavicular joint. An appropriately sized Steinmann pin was used for all fixation (Fig. 2). All tumors of the distal clavicle were resected medial to the coracoclavicular ligament insertion; thus, the coracoclavicular ligament was not reconstructed. Instead, sutures were used to repair the peripheral soft tissue (including remnants of coracoclavicular ligaments) and muscles (including deltoid, pectoralis major, and trapezius) around the allograft in running fashion.

Postoperative protocol

The affected shoulder was immobilized for 3 weeks before rehabilitation. In the reconstruction group, the pin was removed 6 months after surgery except in 1 patient, for whom the pin was removed 3 months after surgery because of a pin track infection. Evaluation of functional outcome was performed at the last follow-up session.

Results

Fourteen patients with a histologically confirmed diagnosis of clavicular ABC were evaluated in this study. The mean age of the patients was 26.2 ± 14.7 years (range, 4-56 years). The mean follow-up period of the patients was 60 ± 37.7 months. All the lesions presented with a fluid-fluid level on magnetic resonance imaging. The demographic, clinical, and surgical characteristics of the patients are presented in Table I.

Extended curettage and segmental resection were performed in 6 patients (42.9%) and 8 patients (57.1%), respectively. The mean Constant-Murley score of the shoulder was 87.7 ± 2.8. The mean Constant-Murley score was 88.2 ± 3.4 in the extended curettage group and 87.4 ± 2.4 in the segmental resection group ($P = .85$). The characteristics of the patients with respect to the type of surgery are presented in Table II.

Two (14.2%) local recurrences were observed in our series, both after extended curettage. The time gap from the index operation to local recurrence was 3 months in one case (case 6) and 12 months in the other (case 4). Local recurrences were treated with segmental resection and reconstructed with a fibular strut allograft. No further recurrence had developed at the mean follow-up of 22.5 months.

Two postoperative complications were observed in our patients, both of which occurred in the segmental resection group. A surgical site infection developed in 1 patient 2 months after surgery and was successfully treated by débridement and 6 weeks of antibiotic therapy. Nonunion of the allograft that was not clinically significant was seen in another patient, who refused surgical treatment.

Discussion

Some authors consider the clavicle to be an expendable bone that can be resected partially or totally without

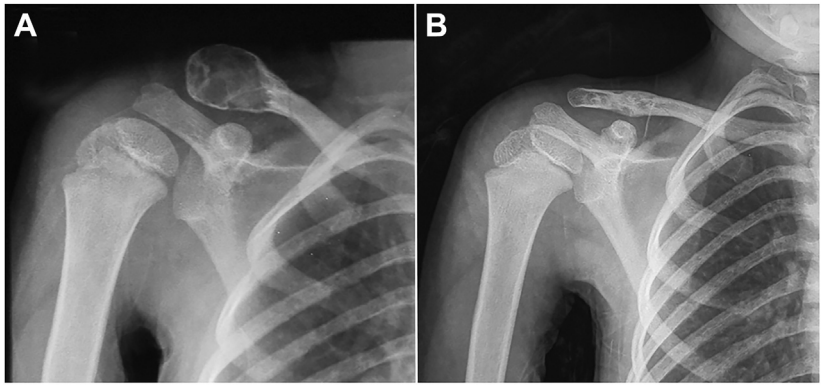

Figure 1 Anteroposterior radiographs of the shoulder of a 4-year-old boy with an aneurysmal bone cyst of the lateral end of the clavicle (case 1). (**A**) Before surgery. (**B**) Three years after extended curettage and bone grafting.

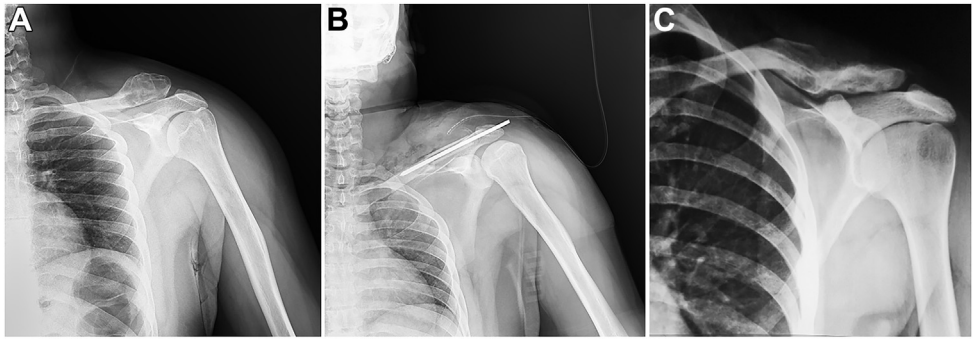

Figure 2 Anteroposterior radiographs of the shoulder of a 24-year-old man with an aneurysmal bone cyst of the lateral end of the clavicle (case 10). (**A**) Before surgery. (**B**) Immediately after segmental resection and bone reconstruction with fibular allograft. (**C**) Three years after surgery.

causing major disability.[3] Yet, Rubright et al[7] reviewed the long-term results of total claviculectomy on shoulder function and revealed that the clavicle contributes to the strength and overall range of motion of the shoulder girdle; thus, patients will gradually lose some compensatory ability and shoulder strength as evidenced by deteriorating outcome measures. Although surgical resection may be a more feasible choice for the treatment of clavicular ABC, it is usually avoided owing to the functional impairment it causes, especially if the coracoclavicular ligaments cannot be preserved.[1,5] We hypothesized that bone reconstruction of the clavicle after resection could reduce this shortage as the length of the clavicle will be preserved. Moreover, in this type of resection, the acromioclavicular joint remains intact to maintain the shoulder's normal form.

In this study, we compared the results of extended curettage with segmental resection and bone reconstruction in the treatment of clavicular ABC. Our results indicate that the function of the shoulder is not significantly different after either surgical approach. The recurrence rate was considerably higher in the extended curettage group (2/6 vs. 0/8), and postoperative complications were more common in the segmental resection group (2/8 vs. 0/6).

Mankin et al[6] reported a local recurrence rate of 50% for ABC of the clavicle (5/10 cases) but did not provide any information about the type of surgery in this location. Recently, Kaiser et al[4] reviewed the outcome of clavicular ABC in 13 patients who were primarily treated with curettage (11/13 cases). Local recurrence developed in 7 patients (58%) in that study at an average of 6 months. The investigators mentioned potential shoulder deformity as a reason to shift toward curettage instead of surgical resection. In total, 2 local recurrences were observed in our series, both of which occurred in patients who were treated with extended curettage (2/6 patients; 33.3%). No recurrence developed in patients who underwent surgical resection and bone reconstruction.

Our results revealed no considerable difference in the function of the injured shoulder after curettage or segmental resection with bone reconstruction. Thus, reconstruction of the resected clavicle could be suggested as an approach that reduces the functional impairment of segmental resection on the affected shoulder while keeping local recurrence at the lowest rate. It is of note that more postoperative complications are expected after segmental resection of the clavicle in comparison with curettage. However, none of these complications led to revision surgery in our series.

The main limitation of this study was the small number of patients in both the curettage and resection groups, which could have adversely affected the power of statistical

Table I Clinical characteristics and outcome of patients with aneurysmal bone cyst of clavicle

ID	Age (yr)	Sex	Location	Expansion (%)	Length (%)	Follow-up (mo)	Treatment	Recurrence	Constant-Murley score
1	4	Male	Lateral	220	20	96	Extended curettage	No	94
2	56	Male	Middle third	230	25	120	Extended curettage	No	87
3	37	Female	Lateral	260	30	84	Extended curettage	No	86
4	18	Male	Lateral	380	34	36	Extended curettage	Yes	88
5	26	Male	Medial	260	37	144	Extended curettage	No	84
6	20	Male	Lateral	250	40	24	Extended curettage	Yes	90
7	16	Female	Middle third	300	42	48	Segmental resection	No	89
8	30	Male	Lateral	170	34	36	Segmental resection	No	91
9	16	Male	Lateral	270	28	24	Segmental resection	No	87
10	24	Male	Lateral	230	20	60	Segmental resection	No	83
11	55	Female	Lateral	350	22	24	Segmental resection	No	86
12	29	Female	Middle third	360	32	36	Segmental resection	No	86
13	17	Male	Lateral	240	24	48	Segmental resection	No	88
14	19	Male	Lateral	270	30	60	Segmental resection	No	89

Table II Comparison of demographic, clinical, and radiologic characteristics between the study groups (extended curettage vs. segmental resection with bone reconstruction)

Variable	Extended curettage (n = 6)	Segmental resection (n = 8)
Age (yr)	27.3 ± 17.9	25.4 ±1 3
Sex		
Male	1 (16.6)	3 (37.5)
Female	5 (83.4)	5 (62.5)
Location		
Lateral	4 (66.8)	6 (75)
Middle third	1 (16.6)	2 (25)
Medial	1 (16.6)	0 (00)
Expansion (%)	283.3 ± 38.8	261.3 ± 52.5
Length (%)	30.3 ± 7.1	29.5 ± 7.5
Follow-up (mo)	66 ± 39.3	55.5 ± 38
Constant-Murley score	88.2 ± 3.4	87.4 ± 2.5

The data are provided as mean ± standard deviation or number (%). A P value of $< .05$ is considered significant.

analysis. Yet, considering the rare incidence of clavicular ABC, the available case series is the best approach for gathering information about the optimal treatment protocol for clavicular ABC, although insufficient. This study could be a starting point for provoking multi-institutional involvement to share experiences with this type of tumor at this location.

Conclusion

The function of the shoulder was not significantly different between extended curettage and segmental resection with bone reconstruction. However, the rate of recurrence was considerably higher in the extended curettage group, and the rate of postoperative complications was considerably higher after segmental resection. Because surgical complications after segmental resection do not usually result in revision surgery, we recommend segmental resection and bone reconstruction for treatment of clavicular ABC.

Disclaimer

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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