

# Hand's aneurysmal bone cyst: A rare localization. Case report and systematic literature review

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## Abstract

Aneurysmal bone cysts are benign, rare bony tumours frequently observed among children and young adults principally located in the long bones, pelvis, and spine and rarely in other anatomical district such as the hand. We report the case of a 12-year-old girl with an aneurysmal bone cyst, in active stage, involving the still-open epiphysis of the fourth metacarpal of the right hand, which was in a first time treated by curettage, and 3 months later, occurring a recurrence, by a radically excision of the bone and reconstruction with a graft from the iliac crest. At 10-year follow-up the patient had good cosmetic results and a functioning hand. We also performed a systematic Literature review in order to retrieve the key information regarding: the diagnosis, the clinical features and the treatment.

## Introduction

Aneurysmal bone cysts (ABC) are benign, rare bony tumours that constitute only 1-2% of all bone tumours, described firstly by Jaffe and Lichtenstein in 1942.<sup>1</sup> ABC can be primary or can arise from a pre-existent lesion however the etiology remains unknown. ABC are most common in the youth, principally located in the long bones, without epiphysis involvement, pelvis and spine. The localization in other anatomical district such as the hand.<sup>2</sup> Histologically, ABC appear as multicystic, lytic lesion with cavernous spaces stuffed with blood. The walls of cysts contain fibroblasts and thin strips of bone. The tumors are separated from the surrounding tissue by a thin layer of periosteal new bone.<sup>3</sup> The most common treatment of an aneurysmal bone cyst is surgical curettage of the lesion, sometimes filling of the cavity with a bone graft and intraoperative adjuvant therapy may be required. Usually the prognosis following

treatment is satisfactory. However, a recurrence rate was reported in the first 2 years after treatment from 10 to 59%, especially in young patients due to skeletal immaturity.<sup>4</sup> The recurrence rate also depends on the histopathological pattern of the lesion. Preoperative staging and stage-dependent surgical procedures are essential for treatment of ABC and the risk of local recurrence is linked to aggressiveness of the primary lesion and to efficacy of the surgery. The aim of the study is to describe a case of a patient with IV metacarpal bon ABC. We also performed a systematic review of the literature in order to retrieve the key information regarding: the diagnosis, the clinical features and the treatment.

## Material and Methods

### Search Criteria

The study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Figure 1). A systematic review of the literature indexed in PubMed, MEDLINE, Cochrane Library and Scopus databases, using as search-terms "Aneurysmal", "Aneurysmatic", "bone", "cyst", "hand" and their MeSH terms combinations (using Boolean operator AND, OR) was performed from 1950 to March 2020. The research was repeated until March 6, 2020.

### Inclusion and Exclusion Criteria

The inclusion criteria of the review were the presence in the evaluated manuscript of: demographic features, symptoms, diagnostic settings, treatment, possible complications and outcomes in patients with ABC of the hand. Only article written in English and available abstract were included. Were excluded from the review: surgical technique reports, expert opinions, studies on animals, unpublished reports, cadaver or in vitro investigations, book chapters, abstracts from scientific meetings.

### Data Collection

Two independent reviewers (A.P and R.V.) separately conducted the described search by title and abstract. If the articles met inclusion criteria following a title and abstract screened, the full text was obtained and reviewed. Any discordance was solved by consensus with a third author (R.D.V.). From each included article were extracted: age and gender of the patients, location of the ABC, type of surgical treatment performed, risk factors, complications related to the treatment performed and

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Key words: Aneurysmal bone cyst, metacarpal, bone graft reconstruction, hand's tumour.

Contributions: RDV, Data collection, text writing, surgical operation, review of the literature; RV, study design, revision of the text, review of the literature; AP, Study design, text revision, review of the literature, bibliographic research; MP, Data collection, bibliographic research, Text revision, figures processing; VC, Data collection, figures processing; CP, Text writing, figures processing; FCT, Study design, text revision, surgical operation.

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Informed consent: Written informed consent for scientific purposes and clinical data collection was obtained according to institutional protocol.

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duration of follow-up. Numbers software (Apple Inc., Cupertino, CA) was used to tabulate the obtained data.

### Statistical Analysis

Categorical variables are presented as frequency and percentages. Continuous variables are presented as means and standard deviation.

## Case Report

A 12-year-old girl, with history of pain in her right hand since 2 months, was visited

at our Emergency Unit. On physical examination there was a slight swelling in the dorsal region of the hand, painful to acupressure. The performed radiographs showed a cystic lesion with expanded cortical near the distal region of the fourth metacarpal, close to the still-open epiphysis (Figure 1a). A MRI was requested. Meanwhile the patient was treated in another hospital by simple surgical curettage. In following three months, she had pain and worsening of dorsal hand swelling. The radiographs and MRI showed a cystic lesion with expanded cortical involving all the fourth metacarpal, also the growth plate (Figure 2). The cortical bone was expanded and thin, which made it impossible to remove the tumour by curettage and filling the cavity with bone graft. Instead the entire diaphysis, including the tumour, was removed and a 7 cm bicortical iliac crest graft, oversizing metacarpal dimension, was harvested and fixed with Kirschner wires to the proximal phalanx and then left in place for six weeks (Figure 3). The hand was also immobilized in a short arm cast for the first 4 weeks. Follow-up radiographs showed that the bone graft healed in the correct position. Macroscopical pattern and microscopy of the tumour showed the typical features of the aneurysmal bone cyst with thin strips of bone and fibroblasts surrounded by blood vessels. At ten year follow up range of movement was satisfactory (Figure 4) only the strength in the operated hand was less than in the other hand but she didn't have functional limitation and referred a normal life. The radiographs are shown in Figure 4.

60 cases (72.3%), pathologic fracture of the involved bone in one case (1.2%). In 47 cases (56.4%) pain and swelling were associated.

Hand's ABC seems to be prevalent in the metacarpal bones (47 patients, 56.4%), followed by the proximal phalanx (19 patients, 23.8%), the middle phalanx (6 patients, 7.2%), the capitate (3 patients 3.6%), the distal phalanx (3 patients, 3.6%), the lunate (2 cases, 2.4%), the hamate (in one

case 1.2%), and the trapezium (in one case 1.2%). In one case the ABC was localized in a sesamoid bone of proximal interphalangeal joint of the index. In 14 patients (16.8%) a traumatic injury of the affected hand was reported. In all case except one (98.8%) a histological diagnosis was made.

### Treatment and outcomes and complication

Eighty-two patients (98.8%) were

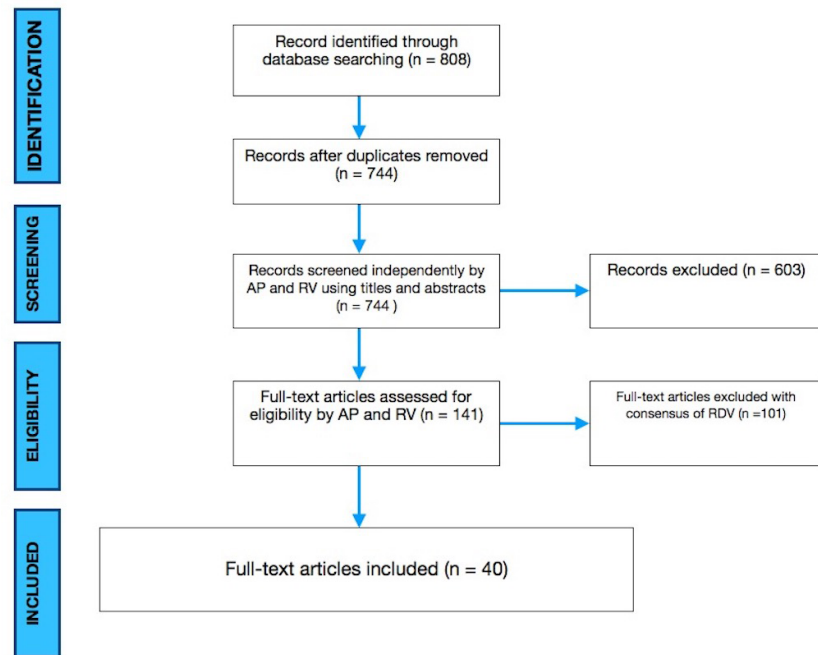


Figure 1. The PRISMA flow-chart.

## Systematic literature review

### Patients features and demographical data

Only a few cases of hand's ABC were reported in the Literature. A total of 744 reports, excluding duplicates, were independently screened, thereby 40 were finally included in our review (Figure 1). Our review showed 83 cases, including our patients, of hand's ABC in the Literature. (4-55) The mean age of included patients was 18.6 (+/- 10.6) years; 50 patients (60%) were paediatric (< of 18 years) the Male/Female ratio was 1.1; the mean follows up time was 52.1 months (+/-52.2). Demographic and clinical features are summarized in Table 1.<sup>1-51</sup>

### Symptoms onset, localization, risk factors and diagnosis

All patients had an onset symptom. Presentation symptoms were: hand's swelling in 70 patients (84%), hand's pain in

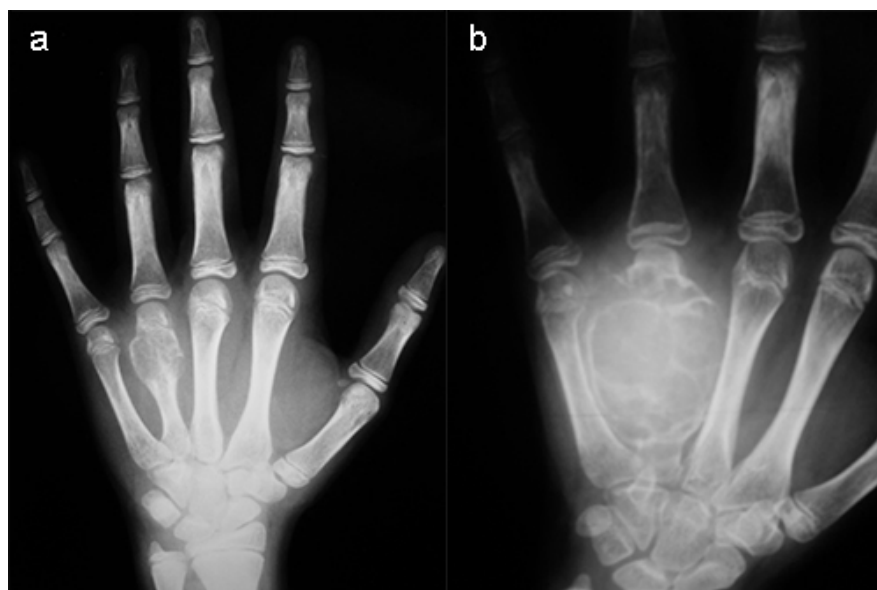


Figure 2. a) Rx pattern before simple curettage. b) Rx pattern three month later simple curettage.

surgically treated. The chosen surgical approaches were: tumour resection and autologous bone graft in 37 cases (44.4%), curettage of the lesion and autologous bone graft in 26 cases (31.2%), curettage of the cyst in 6 cases (7.2%), curettage and bipolar cauterization in 6 cases (7.2%), tumour excision in 6 cases (7.2%), amputation in 2 patients (2.4%) and conservative treatment only in one case.

Concerning surgical outcome: in 68 patients (81.6%) the first surgery was curative without signs of recurrence. Recurrence of the disease was found in 15 patients (18%), therefore they underwent reoperation. In 8 of this patients, tumour resection and autologous bone graft was used as rescue surgery. In 4 patients after recurrence a new curettage of the lesion and autologous bone graft was performed. In one patient after recurrence, cryotherapy and curettage was used as rescue surgery. In one patient the reoperation consisted in the amputation of affected finger. In one patient the reoperation consisted in curettage and bipolar cauterization of the lesion.

About complication, in 15 patients (18%) was found a limitation of range of motion (ROM); therefore, in 5 of these patients was necessary surgical debridement and tenolysis. In 3 paediatric patients (3.6%) a premature physal closure was found.

## Discussion

The origin of the term “aneurysmal bone cyst” derived from two cases of unicameral bone cysts reported by Jaffe and Lichtenstein in 1942.<sup>1</sup> In that report, they noted two large “*peculiar blood-containing cysts,*” which they described as “aneurysmal bone cyst”. Jaffe argued that aneurysmal bone cysts could be the result of a hemorrhagic “blow-out” in a preexisting lesion, which may be destroyed in the process.<sup>1,2</sup> Lichtenstein instead proposed a vascular origin, without specifying whether this lesion was a localized venous thrombosis or a congenital arteriovenous malformation.<sup>3,4</sup> Although many hypotheses have been developed over the years, today the nature of ABC is unclear. Many authors defined aneurysmal bone cysts as a secondary evolution of a pre-existing lesion.<sup>2,3</sup> Other authors proposed two different aetiologies characterizing the lesion as either primary or secondary to a known precursor.<sup>4,5</sup> Most cases are found among children and young adults, in fact the majority of patients with aneurysmal bone cysts are younger than age 20 years. These lesions are principally located in the long bones, pelvis, and spine. Most rarely it is

observed in the hand.<sup>4,19,22</sup>

The natural history of ABC is characterized by four radiologic stages: initial, active, stabilization, and healing. In the initial phase, the lesion is composed of a well-defined area of osteolysis. During the growth phase the lesion grows exponentially leading to the “destruction” of the bone and to the typical “blown-out” radiological

appearance. Then follows a period of stabilization defined on the X-ray as having a “soap bubble appearance” (which is caused by the maturation of the bony shell). Final healing results in progressive calcification and ossification, with the lesion transformed into a dense bony mass.<sup>46</sup>

There has been no agreement on a definitive or ideal treatment in the entire



Figure 3. Rx pattern of reconstruction.

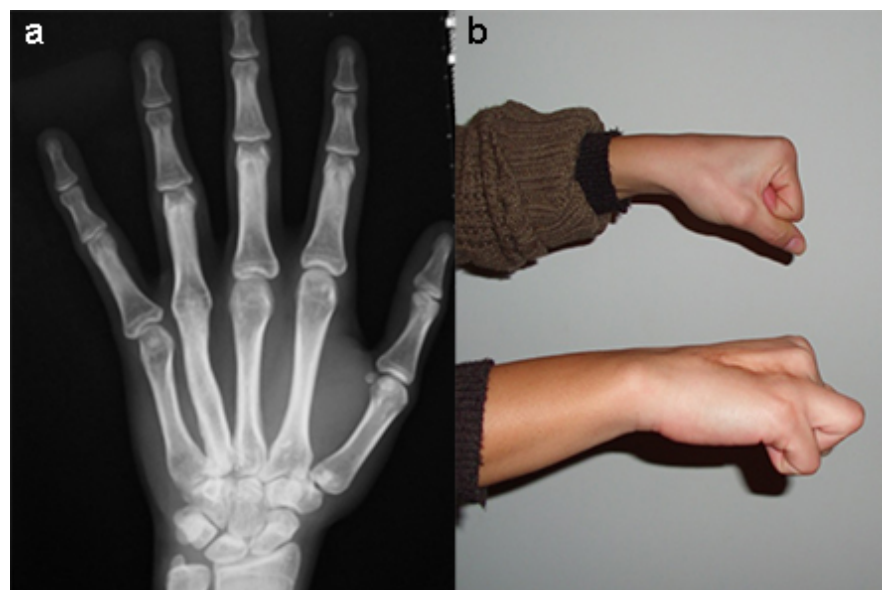


Figure 4. a) Rx at ten years follow up. b) Flexion of fingers at ten years follow up.

Table 1. Demographic and clinical features.

Study	Case	Sex	Age (Year)	Risk Factors	Symptoms	Localization	Complication	Surgical treatment	Donor site	Outcome	Follow Up (month)
Mason <i>et al.</i> 1958	1	M	9	–	P, Sw	PP III F	–	CABG	Iliac crest	Cured	33
Harto-Garofalidis <i>et al.</i> 1967	2	M	17	–	P, Sw	PP I F	Limitation of ROM	TRABG	Tibia	Cured	–
Chari <i>et al.</i> 1971	3	F	16	–	P, Sw	IV MTB	–	TRABG	Tibia	Cured	10
Burkhalter <i>et al.</i> 1978	4	F	22	–	P, Sw	IV MTB	Limitation of ROM	TRABG	Iliac crest	Cured	12
	5	M	8	Trauma	P, Sw	IV MTB	Limitation of ROM	TRABG	Fibula	Cured	18
	6	M	10	–	P, Sw	III MTB	Limitation of ROM, Recurrence	1° Curettage 2° TRABG	Fibula	Reoperation/Cured	72
Fuhs <i>et al.</i> 1979	7	M	17	Trauma	P, Sw	DP IV F	–	Amputation	–	Amputation	12
	8	M	20	Trauma	P, Sw	I MTB	Limitation of ROM	TRABG	Iliac crest	Cured	–
Chalmers <i>et al.</i> 1981	9	M	36	–	P, Sw	PP V F	Recurrence	CABG	–	Reoperation/Cured	–
	10	F	13	–	P, Sw	PP II F	–	CABG	–	Cured	–
	11	M	16	–	P, Sw	PP I F	–	Curettage	–	Cured	–
Barbieri <i>et al.</i> 1984	12	F	35	–	P, Sw	IV MTB	Limitation of ROM	F trasposition	–	Cured	24
	13	F	11	–	P, Sw	II MTB	–	TRABG	–	Cured	48
	14	F	30	–	P, Sw	IV MTB	–	CABG	–	Cured	6
Lin <i>et al.</i> 1984	15	M	16	Trauma	P, Sw	Hamate	–	TE	–	Cured	15
Frassica <i>et al.</i> 1988	16	F	13	–	P, Sw	PP V F	Recurrence	CABG	–	Reoperation/Cured	244
	17	M	20	–	P, Sw	Trapezium	–	TE	–	Cured	176
	18	F	49	–	P	PP I F	Recurrence	CABG	–	Reoperation/Cured	254
	19	F	36	–	P, Sw	V MTB	–	TRABG	–	Cured	132
	20	M	28	–	P, Sw	III MTB	–	CABG	–	Cured	55
	21	M	55	–	P	DP V F	–	CABG	–	Cured	59
	22	M	14	–	PF	I MTB	Recurrence	Curettage	–	Reoperation/Amputation	42
	23	F	14	–	P	IV MTB	–	CABG	–	Cured	43
	24	F	28	–	P	I MTB	–	CABG	–	Cured	32
	25	F	16	–	P	V MTB	Recurrence	1° CABG 2° TRABG	–	Reoperation/Cured	27
Kotwal <i>et al.</i> 1988	26	F	5	Previous surgery CABG	P, Sw	III MTB	–	TRABG	Fibula	Cured	48
Kozlowski <i>et al.</i> 1988	27	M	8	Trauma	P, Sw	III MTB	–	CABG	–	–	–
	28	M	9	–	P, Sw	DP III F	–	Curettage	–	–	–
	29	F	10	Trauma	P, Sw	II MTB	–	TRABG	–	–	–
	30	M	11	–	P, Sw	MP III F	–	CABG	–	–	–
	31	F	13	–	P, Sw	II MTB	–	CABG	–	–	–
Milliez <i>et al.</i> 1988	32	F	10	–	P, Sw	MP III F	Recurrence	CABG	Iliac crest	Reoperation/Cured	6
Dossing <i>et al.</i> 1990	33	F	40	Trauma	P, Sw	MP I F	Recurrence	1° CABG 2° TRABG	–	Reoperation/Cured	18
Mortensen <i>et al.</i> 1990	34	M	6	–	P, Sw	PP III F	–	TRABG	Ulna	Cured	72
Rao <i>et al.</i> 1993	35	M	31	–	P	I MTB	Recurrence	1° CABG 2° TRABG	IV MTB	Reoperation/Cured	44
	36	F	11	–	Sw	MP II F	Recurrence	1° CABG 2° TRABG	PP II F of the foot	Reoperation/Cured	6
Borrelli <i>et al.</i> 1994	37	M	10	–	Sw	III MTB	–	TRABG	Fibula	Cured	30
Mankin <i>et al.</i> 1995	38	F	40	–	P	Lunate	Limitation of ROM	TE, SCA	–	Cured	6
Platt <i>et al.</i> 1995	39	F	14	Trauma	P	Capitate	–	No	–	Cured	16
Apaydin <i>et al.</i> 1996	40	M	32	–	P, Sw	I MTB	–	TRABG	Iliac crest	Cured	18
Sakka <i>et al.</i> 1997	41	M	8	Trauma	P, Sw	DP I F	–	Curettage	–	Cured	36
Athanasian <i>et al.</i> 1999	42	F	14	Trauma	P, Sw	PP III F	Recurrence	1° CABG 2° Crisurgery	Iliac crest	Reoperation/Cured	60
Sroule <i>et al.</i> 2002	43	M	8	Trauma	P, Sw	PP I F	Limitation of ROM	CABG	–	Cured	12
Gundes <i>et al.</i> 2005	44	M	25	–	P, Sw	IV MTB	Limitation of ROM	TRABG	Fibula	Cured	12
Havulinna <i>et al.</i> 2005	45	M	34	–	Sw	Sesamoid II F	–	TE	–	Cured	24
Basarir <i>et al.</i> 2006	46	M	18	–	P, Sw	V MTB	–	CABG	Iliac crest	Cured	18
	47	F	22	–	P, Sw	PP IV F	Recurrence	1° CABG 2° TRABG	Iliac crest	Reoperation/Cured	22
	48	M	16	Trauma	P, Sw	IV MTB	–	TRABG	Iliac crest	Cured	14
	49	F	52	Trauma	P, Sw	II MTB	Recurrence	1° CABG 2° TRABG	Iliac crest	Reoperation/Cured	125
Sakamoto <i>et al.</i> 2006	50	M	15	–	P	Capitate	–	Curettage	–	Cured	48
Sahu <i>et al.</i> 2008	51	F	12	–	Sw	I MTB	–	TE	–	Cured	24
Ozyurek <i>et al.</i> 2009	52	M	21	–	P, Sw	V MTB	–	TRABG	Iliac crest	Cured	36
Jafari <i>et al.</i> 2011	53	M	16	–	Sw	I MTB	Limitation of ROM	TRABG	Fibula	Cured	–
	54	F	6	–	Sw	III MTB	–	TRABG	Fibula	Cured	–
	55	M	17	–	Sw	I MTB	–	TRABG	Fibula	Cured	–
	56	M	27	–	Sw	PP V F	Graft resorption	TRABG	Iliac crest	Cured	–
	57	F	15	–	Sw	III MTB	–	TRABG	Iliac crest	Cured	–
	58	F	10	–	Sw	II MTB	–	TRABG	Fibula	Cured	–
	59	M	9	–	Sw	V MTB	–	TRABG	Fibula	Cured	–
	60	F	23	–	Sw	II MTB	Recurrence	TRABG	Iliac crest	Reoperation/Cured	18
	61	F	15	–	Sw	V MTB	Limitation of ROM	TRABG	Fibula	Cured	–
	62	F	16	–	Sw	III MTB	Limitation of ROM	TRABG	Fibula	Cured	–
	63	M	17	–	Sw	PP II F	–	TRABG	Iliac crest	Cured	–
	64	F	20	–	Sw	PP IV F	–	TRABG	Iliac crest	Cured	–

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Table 1. Continued from previous page.

Study	Case	Sex	Age (Year)	Risk Factors	Symptoms	Localization	Complication	Surgical treatment	Donor site	Outcome	Follow Up (month)
Moussallem <i>et al.</i> 2011	65	M	20	–	P	Capitate	–	CABG	Iliac crest	Cured	24
Kieseritzky <i>et al.</i> 2012	66	M	15	Trauma	P, Sw	III MTB	–	TRABG	Radius	Cured	144
Rajappa <i>et al.</i> 2013	67	F	23	–	P	Lunate	–	TE	–	Cured	72
Singh <i>et al.</i> 2013	68	M	6	–	Sw	III MTB	–	TRABG	Fibula	Cured	24
Al-qattan <i>et al.</i> 2014	69	M	11	–	Sw	MP III F	Asimmetry, PPC	CC	–	Cured	36
	70	F	12	–	Sw	IV MTB	PPC	CC	–	Cured	36
	71	M	6	–	Sw	PP IV F	Recurrence, PPC, Limitation of ROM	1° CABG 2° CC	–	Reoperation/Cured	36
	72	F	20	–	Sw	PP III F	–	CC	–	Cured	36
	73	M	28	–	Sw	MP V F	–	CC	–	Cured	36
	74	F	22	–	Sw	PP IV F	–	CC	–	Cured	36
Pallapati <i>et al.</i> 2016	75	M	29	–	P, Sw	V MTB	–	TRABG	VI MTB	Cured	85
	76	F	14	–	P, Sw	III MTB	–	TRABG	VI MTB	Cured	84
	77	F	15	–	P, Sw	III MTB	–	TRABG	IV MTB	Cured	84
	78	M	23	–	P, Sw	III MTB	–	TRABG	III MTB	Cured	90
Zancolli <i>et al.</i> 2016	79	M	19	–	P	Pisiform	–	TE	–	Cured	–
Nanda <i>et al.</i> 2018	80	F	12	–	P, Sw	III MTB	–	CABG	Iliac crest	Cured	6
Zaidenberg <i>et al.</i> 2018	81	M	21	–	P, Sw	IV MTB	Limitation of ROM	TR Bone Allograft	IV MTB	Cured	96
Dhamangaonkr <i>et al.</i> 2020	82	M	2	–	P, Sw	PP III F	–	CABG	–	Cured	60
Present case	83	F	12	–	P, Sw	IV MTB	Limitation of ROM	1° Curettage 2° TRABG	Iliac crest	Reoperation/Cured	120

CABG: Curettage and autologous bone graft; CC: Curettage and cauterization; Dp: distal phalanx; F: finger; MCB: metacarpal bone; MP: middle phalanx; MTB Metatarsal bone; P: pain; PF: pathologic fracture; PP: proximal phalanx; PPC: premature physal closure; ROM: Range of Motion; SCA: scapho-capitate arthrodesis; Sw: swelling. TE: tumor excision; TRABG: Tumor resection, curettage and autologous bone graft.

scientific literature which is why many different treatment options are used.

Conventional treatments of an ABC, partly similar to simple cysts treatment,<sup>47,48</sup> were represented by: the surgical removal of the entire lesion (en-block or piece-meal) or curettage of the lesion, with or without bone graft, application of liquid nitrogen or by reconstruction using an intramedullary rod, bone auto-graft, polymethylmethacrylate with Steinmann pins, Masquelet technique, implantation of allograft chips.<sup>5-44,49</sup> The efficacy of these methods, specifically of intramedullary nailing and bicortical or tricortical bone grafts from the iliac crest, had already been demonstrated in other studies.<sup>50,51</sup>

Due to its rarity in the hand, no evidence-based treatment regimen has been established, however, from our systematic review it emerged that a radical treatment with tumour resection and bone autograft was associated with the best result and with the lowest number of recurrences. This treatment can be used also as a rescue treatment in the event of disease recurrence.

Our case shows that good results can be achieved although the tumour involved the growth plate and had destroyed the entire diaphysis of the metacarpal and also shows that a bicortical iliac crest graft can transform into an almost normal-looking bone.

## Conclusions

Although most authors recommend a less radical approach, a wide resection and a cortical bone graft is indicated in cases when the articular surface or growth plate is involved or when full bone invasion occurred.

## References

- Jaffe HL, Lichtenstein L Solitary unicameral bone cyst with emphasis on the roentgen picture, the pathologic appearance, and the pathogenesis. *Arch Surg* 1942;44:1004-25
- Mendenhall WM, Ziotecki RA, Gibbs CP, et al. Aneurysmal bone cyst. *Am J Clin Oncol* 2006;29:311-5.
- Vergel De Dios AM, Bond JR, Shives TC et al. Aneurysmal bone cyst. A clinicopathologic study of 238 cases. *Cancer* 1992;69:2921-31.
- Freiberg AA, Loder RT, Heidelberger KP, Hensinger RN. Aneurysmal bone cysts in young children. *J Pediatr Orthop* 1994;14:86-91.
- Mason ML, Wheelock MC. Aneurysmal bone cyst of the hand. *Q Bull Northwest Univ Med Sch* 1958;32:268-71
- Harto-Garofalidis G, Rigopoulos C, Fragiadakis E. Aneurysmal bone cyst of

the proximal phalanx of the thumb: successful replacement by tibial autograft. A case report. *Clin Orthop Relat Res* 1967;54:125-31.

- Chari PR, Rao KM. Aneurysmal bone cyst of the fourth metacarpal bone. *Aust N Z J Surg* 1971;41:166-9.
- Burkhalter WE, Schroeder FC, Eversmann WW Jr. Aneurysmal bone cysts occurring in the metacarpals: a report of three cases. *J Hand Surg Am* 1978;3:579-84
- Fuhs SE, Herndon JH. Aneurysmal bone cyst involving the hand: a review and report of two cases. *J Hand Surg Am* 1979;4:152-9.
- Chalmers J. Aneurysmal bone cysts of the phalanges. A report of three cases. *Hand* 1981;13:296-300.
- Barbieri CH. Aneurysmal bone cyst of the hand. An unusual situation. *J Hand Surg Br* 1984;9:89-92.
- Lin E, Engel J, Bubis JJ, Herman O. Aneurysmal bone cyst of the hamate bone. *J Hand Surg Am* 1984;9:847-50.
- Frassica FJ, Amadio PC, Wold LE, Beabout JW. Aneurysmal bone cyst: clinicopathologic features and treatment of ten cases involving the hand. *J Hand Surg Am* 1988;13:676-83.
- Kotwal PP, Jayaswal A, Singh MK, Dave PK. Aneurysmal bone cyst in the metacarpal of a child: a case report. *J Hand Surg Br* 1988;13:479-80.
- Kozlowski K, Azouz EM, Campbell J et

- al. Primary bone tumours of the hand. Report of 21 cases. *Pediatr Radiol* 1988;18:140-8.
16. Milliez PY, Thomine JM. Rare benign bone tumors and dystrophy in the hand. Review of literature and report of four cases. *Ann Chir Main* 1988;7:189-201.
  17. Døssing KV. Aneurysmal bone cyst of the hand. An unusual location in the first phalanges of the first finger. Case report. *Scand J Plast Reconstr Surg Hand Surg* 1990;24:173-5.
  18. Mortensen NH, Kuur E. Aneurysmal bone cyst of the proximal phalanx. *J Hand Surg Br* 1990;15:482-3.
  19. Rao GS, Keogh P, Webster H, et al. Aneurysmal bone cysts in the hand treated by free non-vascular transfer of metatarsal or proximal phalanx from the foot. *J Hand Surg Br* 1993;18:736-41.
  20. Borrelli J Jr, McCormack RR Jr. Aneurysmal bone cyst involving the long finger metacarpal in a child: a case report. *J Hand Surg Am* 1994;19:800-2.
  21. Mankin KP, Bischoff RJ, Gelberman RH, Rosenberg AE. Aneurysmal bone cyst involving the lunate. *J Hand Surg Br* 1995;20:12-5.
  22. Platt AJ, Klugman DJ. Aneurysmal bone cyst of the capitate. *J Hand Surg Br* 1995;20:8-11.
  23. Apaydin A, Ozkaynak C, Yilmaz S et al. Aneurysmal bone cyst of metacarpal. *Skeletal Radiol* 1996;25:76-8.
  24. Sakka SA, Lock M. Aneurysmal bone cyst of the terminal phalanx of the thumb in a child. *Arch Orthop Trauma Surg* 1997;116:119-20.
  25. Athanasian EA, McCormack RR. Recurrent aneurysmal bone cyst of the proximal phalanx treated with cryosurgery: a case report. *J Hand Surg Am* 1999;24:405-12.
  26. Sproule JA, Salmo E, Mortimer G, O'Sullivan M. Aneurysmal bone cyst of the proximal phalanx of the thumb in a child. *Hand Surg* 2002;7:147-50.
  27. Gudemez E, Eksioğlu F. Aneurysmal bone cyst of the thumb metacarpal: en-bloc resection and free toe phalanx transplantation. *Orthopedics* 2003;26:1229-30.
  28. Havulinna J, Parkkinen J, Laitinen M. Aneurysmal bone cyst of the index sesamoid. *J Hand Surg Am* 2005;30:1091-3.
  29. Başarir K, Saglik Y, Yildiz Y, Tezen E. Aneurysmal bone cyst of the hand: a report of four cases. *Hand Surg* 2006;11:35-41.
  30. Sakamoto A, Tanaka K, Matsuda S, et al. Aneurysmal bone cyst of the capitate: case report and a review emphasizing local recurrence. *Fukuoka Igaku Zasshi* 2006;97:302-7.
  31. Tuzuner T, Subasi M, Alper M. The trapezium: a new location for an aneurysmal bone cyst. *J Hand Surg Br* 2006;31:347-8.
  32. Sahu A, Gujral SS, Gaur S. Extraosseous aneurysmal cyst in hand: a case report. *Cases J* 2008;24:1:268.
  33. Ozyurek S, Rodop O, Kose O et al. Aneurysmal bone cyst of the fifth metacarpal. *Orthopedics* 2009;32.
  34. Jafari D, Jamshidi K, Najdmazhar F et al. Expansile aneurysmal bone cyst in the tubular bones of the hand treated with en bloc excision and autograft reconstruction: a report of 12 cases. *J Hand Surg Eur* 2011;36:648-55.
  35. Moussallem CD, Arnalsteen DM, Khlifi H et al. Aneurysmal bone cyst of the lunate: case report. *J Hand Surg Am* 2011;36:106-9.
  36. Kieseritzky J, Widenfalk B. Treatment of a large aneurysmal bone cyst in a 15-year-old boy using a corticospingial bone graft and a 12-year follow-up after operation. *J Plast Surg Hand Surg* 2012;46:132-6.
  37. Rajappa S, Kumar MM. Aneurysmal bone cyst of lunate treated by excision without intercarpal fusion: a case report. *J Hand Surg Eur* 2013;38:1007-8.
  38. Singh P, Kumar R. Aneurysmal Bone Cyst In Metacarpal of a Child. *J Orthop Case Rep* 2013;3:3-6.
  39. Al-Qattan MM. Bipolar electric cauterization as adjuvant treatment after curettage of aneurysmal bone cysts of the hand. *Ann Plast Surg* 2014;72:38-40.
  40. Pallapati SC, Thomas BP, Anderson GA. En bloc Excision and Matched Metatarsal Transfer for Expansive Benign Osteolytic Lesions of the Metacarpal. *J Hand Surg Am* 2016;41:e417-e423.
  41. Zancolli EP, Ranson JM, Thirkannad SM. Aneurysmal Bone Cyst Involving the Pisiform: A Case Report. *Hand* 2017;12:NP55-7.
  42. Nanda SN, Tripathi S, Shiraz SM, Warriar S. Aneurysmal Bone Cyst of 3rd Metacarpal, Management and Follow-up: A Case Report. *J Orthop Case Rep* 2018;8:9-12.
  43. Zaidenberg EE, Farias Cisneros E, Miller R, Zaidenberg CR. Metacarpal Aneurysmal Bone Cyst En Bloc Resection Reconstructed With Osteoarticular Allograft. *J Hand Surg Am* 2019;44:425.e1-5.
  44. Dhamangaonkar AC, Sathe A, Banerjee S. An Unusual Case of Aneurysmal Bone Cyst of Proximal Phalanx in a 2 Year Old Child. *J Hand Surg Asian Pac* 2020;25:114-8.
  45. Martinez v, Sissons HA. Aneurysmal bone cyst: a review of 123 cases including primary lesions and those secondary to other bone pathology. *Cancer* 1988;61:2291-304.
  46. Dabska M, Buraczowski J. Aneurysmal bone cyst: pathology, clinical course and radiologic appearance. *Cancer* 1969;23:371-88.
  47. Perisano C, Rosa MA, Donati F, et al. Treatment options of simple bone cysts: the role of bone substitutes, growth factors and literature review. *J Biol Regul Homeost Agents* 2016;30:159-64.
  48. Cerciello S, Careri S, D'Adamio S, et al. Aneurysmal bone cysts. *Minerva Ortop Traumatol* 2017;68:220-6.
  49. Careri S, Vitiello R, Oliva MS, et al. Masquelet technique and osteomyelitis: innovations and literature review. *Eur Rev Med Pharmacol Sci* 2019;23:210-6.
  50. De Vitis R, Passiatore M, Cilli V et al. Intramedullary nailing for treatment of forearm non-union: Is it useful? - A case series. *J Orthop* 2020;10;20:97-104.
  51. De Vitis R, Passiatore M, Perna A et al. Modified Matti-Russe technique using a "butterfly bone graft" for treatment of scaphoid non-union. *J Orthop* 2019;27;19:63-6.