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Analysis of the fluid contents of simple bone cyst in the mandible: Blood or serum?

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Abstract

Description of the content of simple bone cyst (SBC) has been controversial. This study aimed to evaluate and give a clearer picture of the contents of the SBC cavity. Nineteen patients SBC confirmed by histopathological examination, between 2014 and 2016, were included in this study. The clinical, radiographic, surgical and laboratory findings of SBC cavity content was analyzed. For statistical analysis, paired samples t-test was used to evaluate the difference of components among cavity fluid, blood and serum. All 19 SBC cases radiographically and surgically revealed a fluid-filled cavity. The average age of the patients was 21.3 ± 13.2 years. Any sex predominance was not found. SBCs were more often found in the anterior mandible site ($n=12$, 63.2%). All lesions were filled with clear straw-colored or low concentrated blood-colored fluid. Although the laboratory analysis of the fluid showed components similar to those in blood and serum, the statistical analysis showed that the fluid components were not significantly different only for eosinophils ($p = 0.43$) and basophils ($p = 0.06$) counts as blood components, and sodium ($p = 0.76$), potassium ($p = 0.08$) and chloride ($p = 0.13$) concentration as serum components. Within a limitation of this study, the results shows that SBC is fluid-filled cavity and the cavity fluid is more likely similar to the serum rather than the blood regarding the internal components.

1. Introduction

The simple bone cyst (SBC) has been defined as a benign bone lesion that lacks of epithelial lining, so-called *pseudocyst*, and the cavity is either empty or filled with fluid ¹⁻³. Various names of the lesion have been used in the literature, including traumatic bone cyst, solitary bone cyst, hemorrhagic bone cyst, extravasation cyst, unicameral bone cyst and idiopathic bone cavity ^{2,4,5}. Studies have reported the prevalence of SBC in the second decade of life ^{6,7}. The sex and site distribution of SBC is quite controversial. The female predominance and involvement of posterior region of the mandible have been documented ^{3,6,8}. However, in a recent analysis, Chranovich and Gomez ⁶ concluded that SBC is equally distributed between the two sexes. Some authors have described the occurrence of SBC in the anterior region of the mandible ^{1,7}. In the most cases, this cyst is discovered accidentally because of the absence of any clinical symptoms. SBC in the jaw is usually detected by panoramic radiography during routine dental examinations. Radiographically, SBCs are seen as areas of well-defined unilocular radiolucency with characteristic interdental scalloping.⁵

Moreover, existing information about the content of SBC cavity has been varied. Some authors believed that cavities are always filled with fluid, whereas others claimed that empty air-contained cyst cavity can be present ⁹. The nature of the fluid was also described as serous or blood ^{4,8,10}. At this point, the question of whether SBC cavities contain blood or serum may arise. Therefore, we collected and analyzed data of 19 patients diagnosed with SBC between 2014 and 2016 in our clinic. We aimed to examine the content of SBC cavity in comparison with the components of blood and serum of the same patient and to give more comprehensive insights into SBC of the jawbone.

2. Materials and methods

2.1. Subjects

From June 2014 to May 2016, of the 27 patients diagnosed with SBCs, 21 patients voluntarily agreed to participate in this study. However, two patients were excluded because of insufficient amount of fluids necessary for analysis. Hence, 19 patients were included in this study.

All participants were informed of the aims of the study and the procedures prior to evaluation, and written consent was obtained from each patient. Relevant data were retrieved from the electronic database. The clinical data consisted of age, sex, history of trauma, existence of any symptoms, and cyst location. The result of cone-beam

computed tomography (CBCT) was used for radiographic evaluation. For the surgical and laboratory data, the content of the SBC, complete blood count, and chemical components of the serum were analyzed.

2.2. Surgical procedure and laboratory analysis

To accurately collect the SBC cavity content, surgery was performed by a skilled surgeon who had more than 10 years of professional experience. The needle of a 10-mL syringe was inserted through the thinnest cortical bone site under CBCT guidance and fluid was aspirated. If the cortical bone was too thick, grinding was carefully performed using a bur so that the needle could be inserted and fluid could be sampled. As advantage, our surgical method made it possible to eliminate external contaminants such as blood and saliva and to collect only the liquid contents of the SBC (Figure 1). After collecting the liquid, a 5-mm hole was used to confirm the absence of cystic lining, and a sample of the bone and surrounding tissues was collected for biopsy.

A blood test including chemistry tests (such as sodium, potassium, and chloride) was performed on the collected liquid sample, and the results were compared with those blood tests (complete and differential blood cell counts and blood chemistry test) results obtained before biopsy.

2.3. Statistical analysis

Statistical analysis was performed with the standard software (SPSS, version 25, IBM Corp., Armonk, NY). Mean with SD values and range was used for descriptive statistics. Statistical differences of SBC fluid content, blood and serum components were compared using paired samples t-test. The 5% cut-point was set for statistical significance.

3. Results

3.1. Subjects

Overall, 19 cases were observed in this study. Table 1 shows the clinical and radiographic findings. The mean age of the patients was 21.3 ± 13.2 years (range 12–57 years); 14 (73.7%) of the 19 patients in their 20s. No sex predominance (male to female ratio = 9:10) was noted. Eighteen (94.7%) asymptomatic cases were detected after routine radiographic examination; pain was reported by only one patient. Two (10.5%) patients had a history of trauma in the jaw.

All lesions were located in the mandible; only seven (36.8%) cases were found in the mandibular posterior region, and the remaining lesions were located in the anterior region (n = 12, 63.2%).

3.2. Computed tomography and laboratory analysis

The mean antero-posterior length of the SBC was 19.3 ± 5.1 mm, the mean buccolingual width was 10.1 ± 3.6 mm, and the mean height was 15.6 ± 3.7 mm on CBCT imaging. Radiographically, all SBCs were unilocular. In all three middle-aged patients, SBC presented as radiolucency combined with radiopaque mass. Displacement or resorption of teeth did not occur.

All lesions were filled with fluid radiographically and upon needle aspiration. The aspirated fluid was either a straw-colored clear liquid or reddish liquid similar to blood, but with a low concentration.

Laboratory analysis of the internal fluid from the lesion showed components similar to those in the blood and serum.

3.3. Statistical analysis

In the statistical analysis, components of the cavity liquid were not significantly different only for eosinophils ($p = 0.43$) and basophils ($p = 0.06$) as blood components, and for sodium ($p = 0.76$), potassium ($p = 0.08$), and chloride ($p = 0.13$) concentration as serum components. Comparison of SBC cavity fluid with blood and serum regarding internal components is presented in Tables 2 and 3.

4. Discussion

SBC of the jaw is considered to be a rare ⁴. Therefore, most literatures are case reports. There are limited number of studies focused on SBC of the jaws with respect to the association of its internal fluid components. This study aimed to report clinical, radiographic, surgical and laboratory findings of SBCs in 19 patients, primarily, focusing on the components of the cyst liquid contents.

SBC cavity in the jaw is often reported to be empty ^{1,11-16}. A recent systematic review of SBC of the jaw revealed that among reported cases more than 50% of SBCs have empty cavities ⁶. However, the cavity being vacant might be mistaken evaluation ^{9,10}. Consistently, in the present study, all 19 SBC cavities were filled with fluid, as confirmed both radiographically and surgically.

Moreover, researchers suggest that the cyst cavity contains blood or serous fluid ^{4,11-14,17,18}. To our knowledge, there has been no report of similarity of SBC cavity content and blood among studies analyzing internal components of

cyst content. It is supposed that contamination of the fluid during creating a window of the cyst wall is a possible explanation of obtaining blood-contained SBC cavity fluid. In our findings, the internal fluid was clear at the start of needle aspiration. A careful suction and chilling were planned to reduce misdiagnosis due to surgical error. Although some fluid samples were blood-contained it is thought to be blood that was sucked from the cavity wall at the end of the aspiration. This study shows that fluid contents have significantly different concentrations of blood components, except for eosinophils and basophils. Rivero et al. ² reported the existence of eosinophils and basophils in the cytological findings of aspirates from idiopathic bone cysts. However, a clear explanation of this phenomenon has not been provided. The role of eosinophils in bone resorption was investigated by Madhusudan et al. ¹⁹ in 47 cases of odontogenic cysts. They believe that eosinophils are attracted by factor released by mast cells. Still, the exact presence and role of these inflammatory cells in SBCs are yet to be studied.

Many theories have been proposed to explain the mechanism of cyst formation. The trauma – hemorrhagic and vascular blockage concepts are most commonly encountered in the literature ^{11-13,15,17,20,21}. Fluid aspirates have been studied to understand the formation of cyst content. It is believed that fluid aspirates have the similar contents of that in serum with respect to proteins and electrolytes ^{14,20,22}. Although this was in consistent with our results, the statistical analysis regarding the concentration of total protein, was significantly different between the fluid and serum (with lower total protein in the fluid). Accordingly, studies have suggested that the fluid content of SBCs represents transudate (contains lower total protein than serum) ^{4,18,22,23}. Accordingly, Skaug ²² claimed that plasma diffusion may play a role in the formation of SBC fluid contents. Suzuki ²⁴ examined fluid components of jaw cysts, other than bone cysts, and proposed the diffusion mechanism of electrolytes from serum through the cyst wall. In the present study, most SBCs (14 of 19 cases) occurred in patients in the second decade of life, and similar prevalence in both sexes ⁶. Eighteen cases in this study were detected after routine radiographic examination. This agrees with previous reports that most SBCs are asymptomatic ⁶.

Lesions are often found in the mandible ⁶, which correlates with our results. Although the posterior mandible is the most common location ^{3,4}, the anterior mandible was most frequently involved (12 of 19 cases) in the present study. Note that in three middle-aged female patients, combination of cemento-osseous dysplasia with SBC was present. This was corroborated with previous reports ^{10,25,26}.

The smaller number of subjects can be considered as the limitation of this study. Therefore, studies investigating

SBC fluid contents in larger number of cases are needed in the future.

CONCLUSIONS

All SBC cavities are filled with fluid, as demonstrated during radiographic examination and surgery. The results of our study shows that SBC cavities are filled with serum-like fluid rather than blood. The nature of SBC fluid contents may have been erroneously described in the literature, at least in cases where accurate aspiration method was not implemented. To describe the nature of the fluid contents, employing a meticulous aspiration technique to obtain true and non-contaminated fluid is suggested.

Author Contributions:

Conceptualization: SY Choi and SY An; data curation: O.B., CH An and JY Ham; formal analysis: O.B., CH An and JY Ham; funding acquisition: SY Choi; investigation: SY Choi, ST Lee and JW Kim; methodology: SY Choi, JY Ham and SY An; project administration: SY Choi and SY An; resources: SY Choi; software: O.B.; supervision: SY An; validation: ST Lee and JW Kim; visualization: SY Choi and O.B.; writing—original draft: SY Choi and O.B.; writing—review and editing: SY Choi and SY An. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

This study was reviewed and approved by the institutional review board (KNUH 2014-01-023) and was in compliance with the Helsinki Declaration.

Informed Consent Statement

Informed consent was obtained for all patients involved in the study including for minors from their parents and/or legal guardians.

Data Availability Statement

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to the founder's policy.

Conflict of interest

The authors declare that there is no conflict of interest in this study.

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Tables

Table 1. Clinical and radiographic findings of 19 cases with SBC

<i>Number</i>	<i>Age</i>	<i>Sex</i>	<i>History of trauma</i>	<i>Symptom</i>	<i>Location</i>	<i>Size of cyst (CBCT; mm)</i>		
						<i>Antero-posterior</i>	<i>Buccolingual</i>	<i>Height</i>
1	22	M	Yes	No	Mn. anterior	15.98	5.14	10.56
2	16	F	Yes	No	Mn. anterior	11.83	9.41	12.4
3	16	F	No	No	Mn. anterior	18.82	8.7	17.44
4	12	M	No	No	Mn. anterior	17.01	8.28	14.95
5	15	F	No	No	Mn. anterior	19.61	5.63	11.92
6	16	F	No	No	Mn. anterior	18.6	7.92	14.83
7	18	M	No	No	Mn. posterior	27.5	12.06	18.74
8	15	M	No	No	Mn. anterior	18.43	10.27	18.53
9	13	M	No	No	Mn. posterior	16.59	9.39	11.4
10	57	F	No	No	Mn. posterior	23.87	19.49	14.92
11	15	F	No	No	Mn. anterior	20.67	9.51	12.32
12	13	M	No	No	Mn. anterior	12.14	6.3	12.15
13	17	M	No	No	Mn. anterior	14.45	9.73	12.42
14	20	M	No	No	Mn. posterior	30.7	11.2	20.03
15	49	F	No	No	Mn. posterior	15.91	16.47	17.32
16	15	F	No	No	Mn. anterior	18.44	9.44	18.89
17	16	M	No	No	Mn. posterior	29.89	12.86	21.37
18	47	F	No	Yes (pain)	Mn. posterior	19.29	14.79	23.23
19	13	F	No	No	Mn. anterior	17.04	6.22	12.63

CBCT, cone beam computer tomography

Mn., mandible

Table 2. Component comparison of the blood and SBC fluid

Components	Blood (mean, SD)	SBC fluid content (mean, SD)	p value
<i>White blood cells</i>	6.85 ± 1.46	3.26 ± 2.49	0.00
<i>Red blood cells</i>	4.77 ± 0.48	2.06 ± 1.51	0.00
<i>Hemoglobin</i>	14.40 ± 1.35	5.93 ± 4.52	0.00
<i>Hematocrit</i>	40.28 ± 6.72	14.69 ± 12.37	0.00
<i>Segmented neutrophils</i>	53.94 ± 10.11	40.57 ± 9.69	0.00
<i>Lymphocytes</i>	34.64 ± 8.79	44.12 ± 11.13	0.00
<i>Monocytes</i>	5.75 ± 1.43	7.47 ± 2.96	0.01
<i>Eosinophils</i>	2.80 ± 1.85	3.46 ± 3.60	0.43
<i>Basophils</i>	0.59 ± 0.22	1.62 ± 2.20	0.06

Table 3. Component comparison of the serum and SBC fluid contents

Components	Serum (mean, SD)	SBC fluid content (mean, SD)	p value
<i>Total protein</i>	7.25 ± 0.52	6.40 ± 0.65	0.00
<i>Total cholesterol</i>	157.31 ± 35.70	198.28 ± 45.56	0.00
<i>Sodium</i>	140.95 ± 3.20	140.68 ± 4.82	0.76
<i>Potassium</i>	7.39 ± 9.11	13.32 ± 19.63	0.08
<i>Chloride</i>	101.68 ± 3.27	102.89 ± 5.47	0.13

Figures

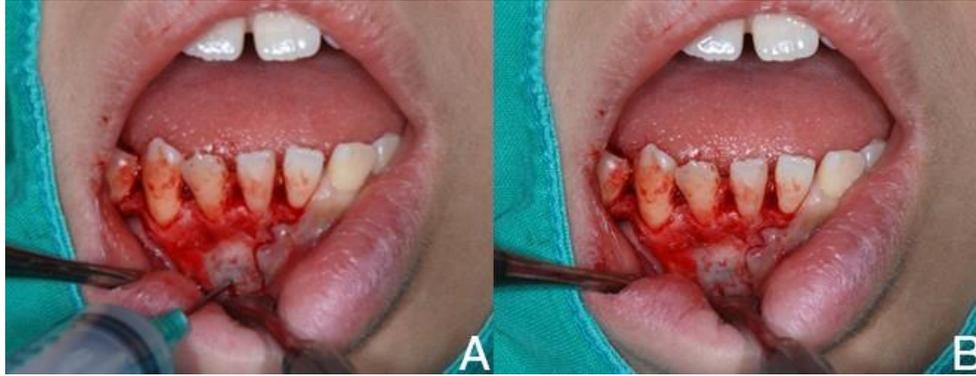


Figure 1. **A**, when approaching the oral cavity, a thin bone portion is observed on the buccal side of the lesion, and the inside is slightly visible; **B**, by perforating a thin bone part with a 10-mL syringe, the fluid inside the lesion is collected without contamination with the surrounding blood or saliva