

# Clinical, statistical and chemical study of sialolithiasis

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**Abstract** (J Korean Assoc Oral Maxillofac Surg 2012;38:44-9)

**Introduction:** Sialolithes are initiated by localized deposition of calcified material in the salivary glands. And that may even cause various symptom especially swelling and pain. This study purposes to collect statistical data of sialolithiasis for clinical analysis.

**Materials and Methods:** Among forty seven patients who have visited Seoul National University Dental Hospital during 2004-2009, patients' age, sex, location and size of stone, radiodensity of stone, symptom, surgical procedure were investigated. Statistical correlation between size, location, symptom was evaluated. Chemical composition was analyzed for 3 sialolithes.

**Results:** The average age was 41.4 years. Sialolithiasis had slight female predilection (57.4%). Most cases occurred in the submandibular glands (91.5%). And most cases had radiopaque features (95.8%). The average size was 7.17 mm. The most frequent location of the stones were the duct orifice and the submandibular gland hilum (16 cases in each), followed by the middle part of the duct (n=8), the intraglandular area (n=4), and the proximal part of the duct (n=3). Eleven cases were asymptomatic. Thirty six cases had complaints of pain, swelling, hardness, and decrease in saliva flow (multiple symptoms). Various methods of surgery was performed. Two cases were self-removed. Thirty seven cases underwent procedure involving stone removal alone. Six cases underwent gland extirpation, and two cases underwent ductoplasty.

**Conclusion:** There was no statistical correlation between size, location, and symptoms. Sialolith was composed of Ca (58.5-69.3%), P (30.7-35.7%), organic material, and trace inorganic material.

**Key words:** Salivary duct stones, Salivary glands, Salivary gland calculi, Chemical composition

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## I. Introduction

Sialolithiasis is a disease caused by the partial deposition of calcific materials in the salivary gland. Generally, it develops in the submandibular gland due to the viscosity of saliva and gravity. Though the exact mechanism has yet to be identified, there are many hypotheses including precipitation of calcium salts due to the undercurrent of salivation, damage of the duct epithelium, inflammation, biological factors, etc. Sialolithiasis does not develop frequently, so there are not enough international research studies and data on its basic elements such as expression aspects and components of salivary stone. Therefore, this research collected clinical

data on sialolithiasis patients who visited Seoul National University Dental Hospital, analyzed the correlation between size, location, and symptoms statistically, and identified its composition by requesting the component analysis of 3 samples.

## II. Materials and Methods

### 1. Materials

This study was conducted targeting 47 sialolithiasis patients who visited Seoul National University Dental Hospital during the period 2004-2009 to collect and analyze medical records containing the patients' age, gender, size and position of the salivary stone, radiolucency, symptoms, and treatment.

### 2. Statistics

Statistical analysis was performed to identify the correlation between size, location, and symptoms of the salivary

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stone. For patients with computed tomography (CT) data, the salivary stone's size was the longest major axis in CT. For patients without CT data, it was the value in plain film considering the magnification ratio. Moreover, if there were multiple salivary stones, the largest value was the representative value. Location was divided into 5 areas with the duct divided into 3 areas including duct orifice, duct middle part, and duct proximal part, and with the hilum/intraglandular portion divided separately. For patients with CT data, CT was used to classify location; for patients without CT data, sialogram was used.

To analyze the correlation between each factor, the SPSS version 17.0 (IMB, New York, NY, USA) program was used. Non-parametric test was used due to the small number of samples with  $P$ -value $<0.05$ . Mann-Whitney U test was applied to compare the average size of the salivary stone by symptom, Kruskal-Wallis test was conducted to compare the average size according to the location of the salivary stone, and Fisher's exact test was used to verify the correlation between the location of the salivary stone and symptoms.

### 3. Components

Among the collected samples (Fig. 1), 3 were sent to the Korea Testing & Research Institute to analyze their chemical composition. A device combining a scanning electron microscope and an energy dispersive x-ray spectroscope (energy dispersive x-ray microanalysis detector system, FEI Nova NanoSEM 400/Thermo Science Noran SYSTEM SIX 2; FEI Company, Hillsboro, Oregon, USA) (Fig. 2) was used,



**Fig. 1.** Photo of the removed salivary stone.

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and the composition of the salivary stone was confirmed by comparing the value of x-ray emitted by each component with the specific value of known existing materials.

## III. Results

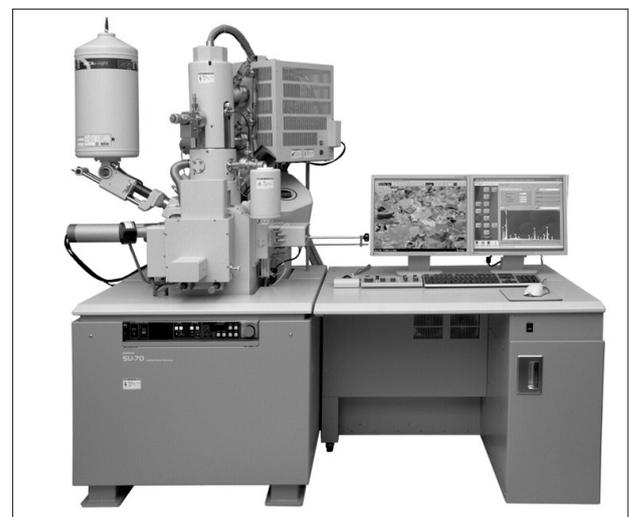
### 1. Patients

1) Age and gender: The average age of 47 patients was 41.4 years, ranging from 8 to 69. Males numbered 20 (42.6%), and females, 27 (57.4%).

2) Location: 4 cases developed in the parotid gland (8.5%), and 43 cases developed in the submandibular gland (91.5%). A total of 25 cases developed on the left (53.2%), and 22 cases, on the right (46.8%). Among the 5 areas, 16 cases developed in the duct orifice (34%), 8 cases, in the duct middle part (17%), 3 cases, in the duct proximal part (6.4%), 16 cases, in hilum (34%), and 4 cases, in the intraglandular portion (8.5%).

3) Size: The average size of the salivary stone was 7.17 mm, ranging from 3 to 20 mm.

4) Radiolucency: The radioopaque salivary stone made up 95.8%, and the radiolucent salivary stone, 4.2%. The radiolucent salivary stone could only be examined in the sialograph.



**Fig. 2.** Energy dispersive x-ray microanalysis detector system.

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5) Symptom: A total of 36 patients had symptoms when they visited, including pain, swelling, hardness, and decrease in saliva flow. On the other hand, 11 patients were asymptomatic.

6) Treatment: In 2 cases, the salivary stone was self-removed (4.2%), with 37 cases undergone a procedure involving stone removal alone (78.7%), 6 cases (12.7%), submandibular gland extirpation, and 2 cases (4.2%), ductoplasty to discharge it naturally.

2. Statistics

In the statistical analysis to examine the correlation between data, among 36 cases of sialolithiasis with symptom, the average size of the salivary stone was 6.889±3.223 mm. In 11 asymptomatic cases, the average size of the salivary stone was 8.091±4.630 mm. There was no correlation between the size of the salivary stone and symptoms ( $P>0.05$ ).

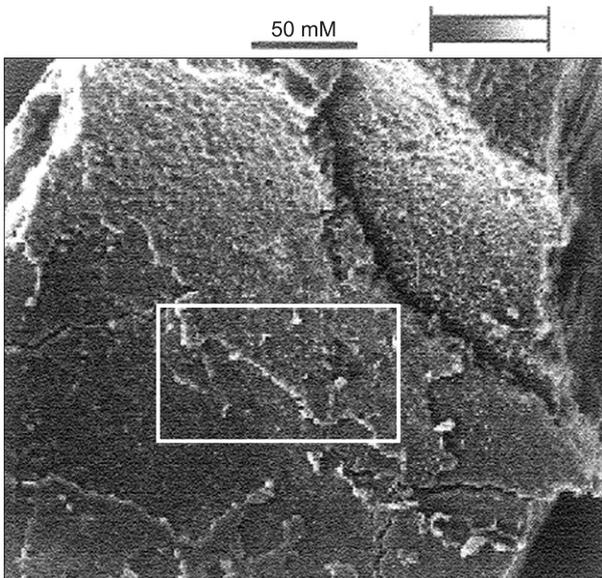
In 16 cases, the salivary stone was in the duct orifice (34%),

with average size of 6.00±3.05 mm. Eight cases were in the duct middle part (17%), and the average size was 7.00±2.58 mm. Three cases were in the duct proximal part (6.4%), with average size of 8.00±6.08 mm. 16 cases were in hilum (34%) with average size of 8.50±4.25 mm. Four cases were in the intraglandular portion (8.5%) with average size of 6.25±0.96 mm. There was no correlation between size and location of the salivary stone ( $P>0.05$ ).

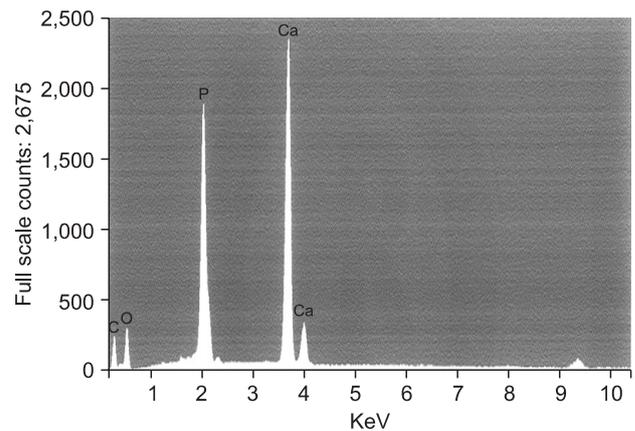
Thirteen out of 16 duct orifice cases had symptoms (81.3%), 6 out of 8 duct middle part cases (75.0%), 3 out of 3 duct proximal part cases (100%), 10 out of 16 hilum cases (62.5%), and 4 out of 4 intraglandular portion cases (100%). There was no correlation between the location of the salivary stone and symptom ( $P>0.05$ ).

3. Components

Salivary stones consisted of organic and inorganic materials in varying ratios. The major components were C and O (organic materials) and Ca and P (inorganic materials). The Ca : P ratio varied from 1.64 to 2.26. The proportion of Ca to all inorganic materials was 58.5-69.3%, and that of P was 30.7-35.7%. There were also microelements such as Mg, Na, and S.(Table 1, Figs. 3, 4)



**Fig. 3.** Surface of salivary stone enlarged using electron microscope. *Ho-Kyung Lim et al: Clinical, statistical and chemical study of sialolithiasis. J Korean Assoc Oral Maxillofac Surg 2012*



**Fig. 4.** Peak of each component measured by spectrum analysis. *Ho-Kyung Lim et al: Clinical, statistical and chemical study of sialolithiasis. J Korean Assoc Oral Maxillofac Surg 2012*

**Table. 1.** Analyzed composition of salivary stone

	C	O	Ca	P	S	Na	Mg	Ca/inorganic components (%)	P/inorganic components (%)
1	15.58	28.92	38.48	17.02				69.3	30.7
2	39.86	36.85	13.62	8.31	1.36	0.37	0.37	58.5	35.7
3	6.18	45.90	31.65	15.53				66.1	32.4

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## IV. Discussion

According to the research of Escudier and McGurk<sup>1</sup>, the incidence rate of sialolithiasis is 59 per 1 million people or 0.0059%, while we have had 30,000 patients per year and sialolithiasis patients numbered 47 for 6 years, which suggests the incidence rate of 0.0261% and it is different from the above study. A research using corpses reported that 1.2% of the cases showed sialolithiasis<sup>2</sup>.

In contrast to existing research studies, which reported a male predilection, our data revealed a slight female predilection<sup>3</sup>. A study reported that sialolithiasis develops frequently among people in their 30s-60s<sup>4</sup>, and another study reported that sialolithiasis afflicts 3% of children<sup>5</sup>. With respect to age, the existing research studies reported similar results to this study. In terms of size, the average size in the existing research studies was 7 mm, which was similar to our data; a 7-cm salivary stone was reported<sup>6,7</sup>.

Salivary stone is known to develop frequently in the submandibular gland (about 90%)<sup>8</sup> and unilaterally<sup>3</sup>. Incidence in the parotid gland is rare (less than 10%) caused by gravity or shape of duct, and even rarer in the sublingual gland or minor salivary gland<sup>8</sup>. According to the research of Capaccio et al.<sup>9</sup>, salivary stone generally develops in the duct proximal part or hilum; incidence in the intraglandular portion is rare. This result is similar to our findings.

There are some hypotheses as to the cause of salivary stone. According to the first hypothesis, it is caused by reduced saliva flow, dehydration, and change of pH combined with a high concentration of mucous plug<sup>10</sup> or membrane phospholipid<sup>11</sup> in the redundant secretory vesicle, which acts as nidus.<sup>10</sup> Second, Marchal et al.<sup>12</sup> cited food, germs, and foreign materials were flowed into the duct as factors triggering the formation of salivary stone. This hypothesis was supported by Teymoortash et al.<sup>13</sup>, and the analysis using polymerase chain reaction revealed that most germs in the salivary stone were *streptococcus*.

Salivary stones consisted of organic and inorganic materials in varying ratios. Organic materials included glycoprotein, mucopolysaccharide, cellular debris, etc., whereas inorganic materials were calcium carbonate or calcium phosphate with other materials such as manganese, iron, and copper<sup>14</sup>. According to the research of Kasaboğlu et al.<sup>15</sup>, among the inorganic materials in the salivary stone, Ca constituted 71.9%, and P 25.4%, with other miscellaneous components. This is similar to our result. With respect to chemical composition, the major components are microcrystalline

apatite and whitlockite<sup>16</sup>. Microcrystalline apatite was all over the salivary stone, whereas whitlockite was at the center<sup>17</sup>. It is caused by the concentration of calcium and phosphate. Lower concentration increases the ratio of microcrystalline apatite<sup>18</sup>. Moreover, brushite and weddellite, which are deemed to form in the early stage of salivary stone, were found at the fringes of the salivary stone<sup>16</sup>. This research analyzed the components but did not investigate the chemical composition.

In the past, standard film was used to diagnose salivary stone. It is useful to identify salivary stone in the duct, but detecting salivary stone in the salivary gland, small salivary stone, and radiolucent salivary stone is difficult<sup>19</sup>. According to the research of Gorlin and Goldman<sup>2</sup>, 20% of the salivary stones were radiolucent. CT is also used to diagnose sialolithiasis, but it cannot examine salivary stone if thick slices are used<sup>20</sup>. Magnetic resonance imaging (MRI) has been adopted recently. Though widely used as an innovative method that resolved many existing problems, MRI takes a long time to reconstruct the image and it is expensive. Moreover, the image may be distorted due to artifact if there is a prosthetic in the mouth<sup>21</sup>.

Recently, diagnosis using endoscope has been widely used. It can examine the duct with high accuracy and remove the salivary stone during diagnosis<sup>22</sup> but may damage vessel perforation or surrounding blood vessel and nervous system due to the hard instrument<sup>23</sup>. Nonetheless, it is the most popular method with its various advantages, substituting for conventional methods.

The traditional treatment of sialolithiasis was removal by surgery. If the salivary stone is in the duct orifice, surgery to remove the salivary stone is performed using duct dilatation, incision, or exposure. If it is in the duct proximal part or intraglandular portion, salivary gland extirpation is considered<sup>24</sup>. In particular, if the salivary stone is in the parotid gland, parotid gland extirpation not for the superficial layer but for the entire layer is done to prevent relapse<sup>25</sup>. However, salivary gland extirpation may damage a nerve or cause aesthetic dissatisfaction<sup>26</sup>. In case of submandibular gland extirpation, 1-8% permanent damage of the marginal mandibular branch in facial nerves and 1-5% permanent damage of the lingual nerve were reported<sup>27,28</sup>. Likewise, in case of parotid gland extirpation for the superficial layer, 16-38% temporal damage of facial nerves and 9% permanent paralysis of facial nerves were reported<sup>29</sup>. Frey's syndrome was rare<sup>30</sup>. Other side effects of salivary gland extirpation include sialocele, fistulous opening, infection, and hematoma<sup>31</sup>.

Recently, conservative methods to remove the salivary stone have been widely used. Various research studies using scintigraphic or histological method proved that the removal of the salivary stone hardly causes irreversible damage to gland tissues regardless of chronic inflammation caused by the salivary stone<sup>32-34</sup>. According to the research of Yoshimura et al.<sup>33</sup>, after removing the salivary stone, 78% of the function of gland tissues was recovered. Marchal et al.<sup>34</sup> reported that, after analyzing histologically, more than half of the cases showed normal shape. Such conservative methods include shockwave lithotripsy, salivary stone removal using sialoendoscopy, interventional radiology, and botulinum toxin therapy.

According to references, sialoendoscopy recorded 89% success rate in removing the salivary stone of the submandibular gland and 83-86% success rate in removing the salivary stone of the parotid gland<sup>35,36</sup>. Though there is a limitation on removing the salivary stone in the salivary gland or buried in the duct's wall<sup>37</sup>, sialoendoscopy is the most popular method due to its various advantages.

So far, we examined the expression pattern of sialolithiasis and various methods of its diagnosis and treatment. Though there are conflicts with regards to prevalence rate and cause of incidence, the references and this research obtained similar results as to the location of incidence, age, size, and components. Specifically, this research and the references both reported that sialolithiasis generally developed in the duct proximal part or hilum, the average age was 40s, the average size was 7 mm, and the Ca : P ratio was around 2.00. With respect to diagnosis and treatment, more conservative and non-invasive approaches have recently gained greater popularity compared to traditional surgeries.

## V. Conclusion

After performing clinical treatment, statistical analysis and component analysis for the 47 sialolithiasis patients who visited Seoul National University Dental Hospital during the period 2004-2009 and reviewing references, we achieved the following results:

1. The average age was 41.4 years, with slight female predilection. Most of sialolithiasis developed in the submandibular gland, and were of the radioopaque. A total of 36 patients had a symptom when they visited, with the size of sialolithiasis ranging from 3 to 20 mm for an average size of 7.17 mm. Most salivary stones were in the duct orifice and hilum. 4.2% of the cases

were self-removed, with 78.7% undergone procedure to remove the salivary stone, 12.7%, submandibular gland extirpation, and 4.2%, ductoplasty to self-removal. There is a need to identify the position and size of the salivary stone before surgery and select an appropriate treatment method.

2. We conducted statistical analysis to examine the correlation between size, symptom, and location of the salivary stone but found no significant correlation ( $P>0.05$ ). More accurate result will be achieved if there are more samples.
3. The major components of the salivary stone were C and O (organic materials) and Ca and P (inorganic materials). The Ca : P ratio was 1.64-2.26; the proportion of Ca to all inorganic materials was 58.5-69.3%, and that of P was 30.7%-35.7%. There were also microelements such as Mg, Na, and S. Although the analysis of chemical composition was performed for a small amount of salivary stone, the treatment method related to the dissolution of calcium salts can be devised if the average chemical composition of the salivary stone is identified based on more analyses.
4. Most treatments of sialolithiasis we did were surgeries; in the references, however, there are various conservative treatments available. It will be useful to try many non-invasive methods for cases wherein conservative treatment is possible considering the location of the salivary stone and accessibility of surgery.

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