Analysis of Gallstone components using FE-SEM and EDS

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Abstract

Gallstone is one of the most painful diseases for a mechanical stimulation of stones. However, the cause of gallstones is not yet clear and not well known. In this study, the surface structure of gallstones was observed using Field Emission Scanning Electron Microscope (FE-SEM). In addition, elemental analysis of the gallstone surface was also performed using Energy Dispersive X-ray Spectrometry (EDS). In the analysis using FE-SEM, we confirmed the surface structure of gallstones. In the analysis using EDS, we detected inorganic components by elemental analysis.

Key words: gallstone, FE-SEM, EDS, microstructure, elemental analysis, inorganic component

Introduction

It is said that gallstone prevalence in Japan is about 10% and the cholelithiasis is increase with age [1]. There are a variety of treatment methods to treat cholelithiasis, but these can't be completely disrupted gallstones at the bile duct, and the problem such as damage to the bile duct and recalculus by fragment may occur. As for gallstones contained high calcium component and bilirubin stones, the treatment effect can't be expected by using solvent. It is necessary to remove the stones with surgical operation [2].

Therefore, to crush gallstones by using ultra-short pulse laser is suggested. It is crushed the gallstones at molecular level, to prevent damage to the bile duct are expected. In this study, the surface structure of gallstones was observed using Field Emission Scanning Electron Microscope (FE-SEM) as the first step to establish a new laser gallstone treatment. Elemental analysis of the gallstone surface was also performed using Energy Dispersive X-ray Spectrometry (EDS).

Experiment

In the experiment, cholesterol gallstones (cholesterol stones) and the pigment gallstones (bilirubin calcium stones and black stones) were used as samples. The gallstone sample was divided into 3 mm size, the sample was fixed on the stage, and the surface structure was observed. We set the magnification at observation to 300 and 600 times. In addition, the inorganic components were analyzed from the microscopic image by EDS.

Table I. Measurement condition with FE-SEM and EDS

magnification	300~600 times
accelerating voltage	14~15 kV
cumulative number	20

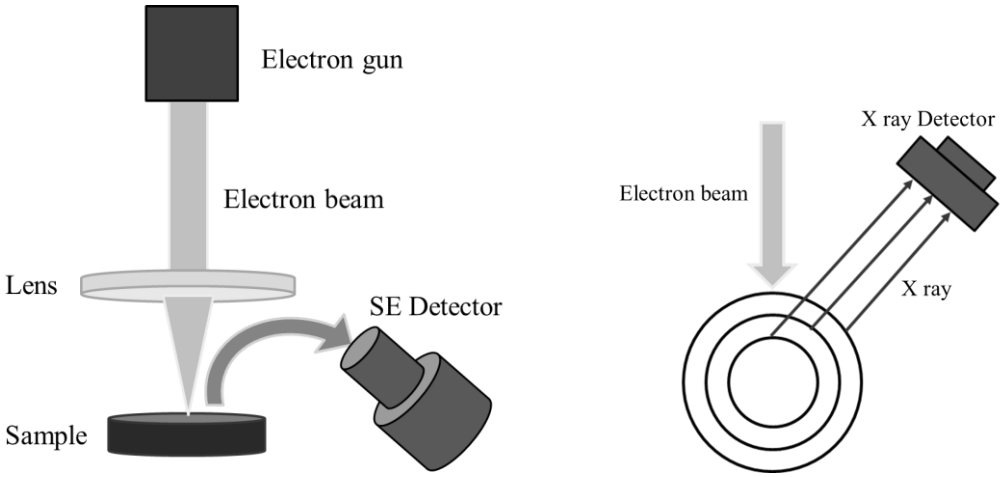

Fig.1 FE-SEM and EDS

Result and Discussion

In the analysis using FE-SEM, we confirmed the surface structure of gallstones. In the microscopic image of cholesterol stone, a plate-like structure due to cholesterol was confirmed. In the microscopic image of bilirubin calcium stone, the microstructure of bilirubin calcium as the main component was confirmed. The microstructure of bilirubin calcium could also be confirmed with black stone.

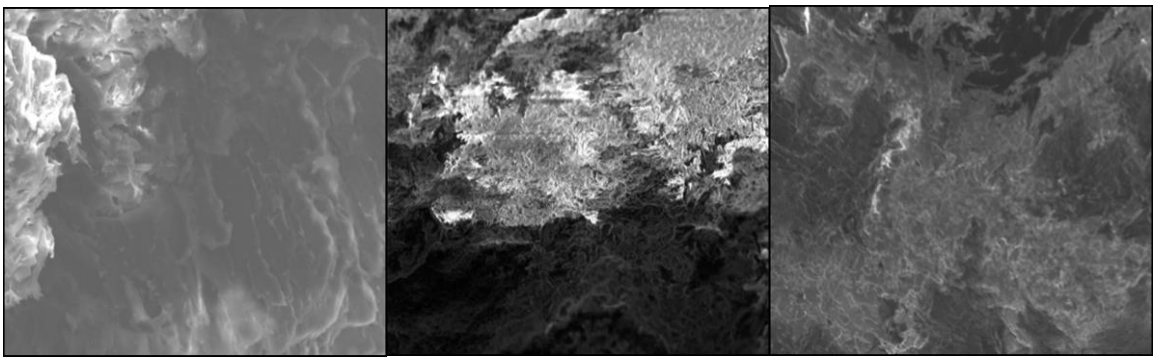

Fig.2 Microscopic image of gallstones with FE-SEM
Cholesterol stone (left), Bilirubin stone (center), Black stone (right)

In the analysis by using EDS, the inorganic components were detected by elemental analysis. With cholesterol stones, we detected calcium, sodium, sulfur. For bilirubin calcium stone, we detected calcium, phosphorus, sodium, aluminum, magnesium and others. In addition, with black stone, the same components as bilirubin calcium stone were contained, but sulfur was detected instead of magnesium. Calcium was derived from calcium salt in vivo. Also, it becomes clear that calcium is the main component of gallstones. The element distribution in the gallstone could be clarified.

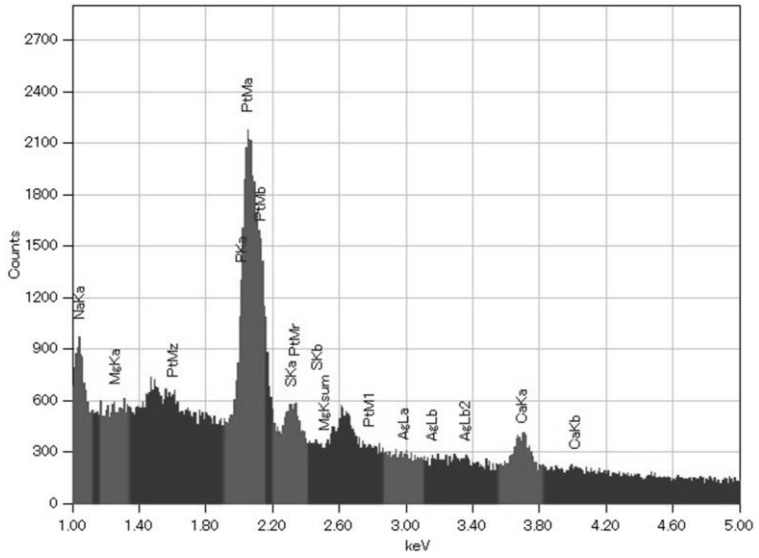

Fig.3 EDS spectrum of cholesterol stone

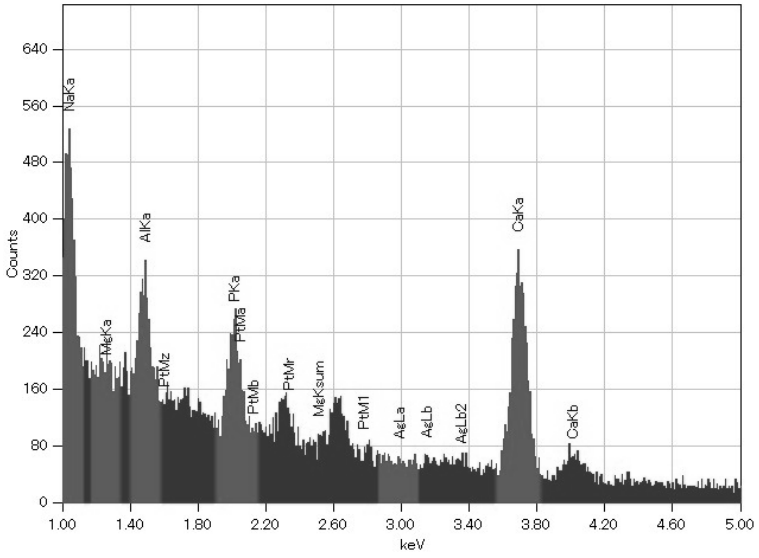

Fig.4 EDS spectrum of bilirubin stone

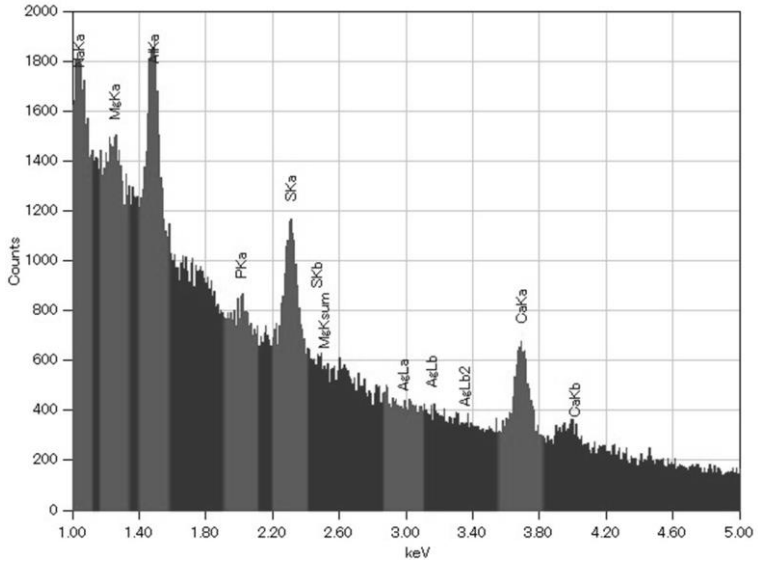

Fig.5 EDS spectrum of black stone

Future works

In the future, we quantitatively analyze the inorganic components of gallstones using EDS. It is planned to analyze the surface structure of gallstones using other analytical equipment. In addition, we plan to compare data of other analytical instruments and identify gallstone components.

Reference

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