Common bile duct stones are mainly brown and associated with duodenal diverticula

O Sandstad, T Osnes, V Skar, P Urdal, M Osnes

Abstract

This study investigated the composition of common duct gall stones from 61 patients, aged 49–94. The stones were collected endoscopically with a dormia basket after endoscopic papillotomy. The cholesterol content was measured both by infrared spectroscopy (mean 29%, range 0–99%) and enzymatically (mean 23%, range 0–96%). The results of the two measurements showed good correlation ($r^2=0.92$), indicating that cholesterol can be adequately measured enzymatically. Most of the stones were pigment stones. When examined by infrared spectroscopy, 44 stones (72%) contained less than 50% cholesterol (mean 4%, range 0–23%). The bilirubinate content in these stones was 56%, range 12–100%. Forty two of these stones were brown stones, and only two were black stones. Pigment stones were associated with juxtapapillary diverticula ($p<0.01$). It was found that brown pigment stones were the commonest symptomatic bile duct calculi in the patients studied, who are representative of a Western population. (Gut 1994; 35: 1464–1467)

Gall stones have a prevalence of 10–30% in the normal population, and increase with age. Most gall stones are asymptomatic, but symptomatic stones in the common duct, either migrated from the gall bladder or formed in the common duct, always require treatment to prevent and relieve stasis and infection.

The main components of gall stones are cholesterol and bile pigments. Seventy to 90 per cent of gall stones obtained at cholecystectomy from patients in a Western society are cholesterol stones, consisting of more than 50% cholesterol. pigment stones can be classified visually as black stones, associated with haemolysis, or brown stones, which are thought to result from infection and stasis. Stones in the common duct are often brown pigment stones. There has been no material published, however, on the composition of stones extracted endoscopically.

The aim of this study was to determine cholesterol and bilirubinate content in endoscopically obtained gall stones, and to describe the patient population with common bile duct stones in a tertiary care endoscopy unit. We decided to compare the results of infrared spectroscopy with those of an enzymatic assay to simplify future measurement of cholesterol content. We also wanted to explore our previous finding that duodenal diverticula predispose to common bile duct stones, with regard to the type of stone.

Methods

During the years 1987–90 common bile duct stones were collected endoscopically after papillotomy in 61 patients. Mean age of the patients was 74 years (range 49 to 94). Thirty four were women (mean age 75) and 27 men (mean age 74). All were Norwegian, apart from one woman of oriental origin. Eight had previously been treated with a partial gastrectomy and 10 had had a previous cholecystectomy. The sample population was representative of patients investigated for common bile duct stones in our department as these have a mean age of 75 years, 56% are women and 15% have previously been treated with a partial gastrectomy. None of the patients included were known to suffer from haemolytic disease, chronic pancreatitis or chronic liver disease. One gall stone was examined from each patient.

The presence of duodenal diverticula was sought and noted before cannulation of the papilla of Vater. All stones were caught in a dormia basket in the common bile duct. The stones were stored at −20°C until analysis.

Before analysis the stones were dried in a vacuum oven for 10 hours and weighed. A representative part, either the whole stone or a cross section of the stone was selected, crushed, and 1 mg was prepared with 200 mg KBr for infrared spectroscopy. The
infrared spectra, Nicolet FT-IR 25 (Nicolet Instrument Corp, Madison, WI), of the stones were compared with those of 1 mg pure cholesterol (Sigma, IL, USA) or bilirubinate. Several wavelengths were tried before the wavelength for measurement of cholesterol content was chosen. They all gave similar results, and the wavelength 1055 cm\(^{-1}\) was chosen. Contributing to our choice of wavelength was that at about 3400 cm\(^{-1}\), which was the wavelength used by Trotman et al, problems of interference with hydroxyl groups and amines were to be expected. For bilirubinate analysis the wavelengths 1662 and 1622 cm\(^{-1}\) were chosen for quantitation. A 5 mg sample was taken from each stone and analysed enzymatically for its cholesterol content. This assay was performed without knowledge of the infrared spectroscopy results. The stones were classified as cholesterol stones if the infrared spectroscopy measured >50% cholesterol. Stones with <50% cholesterol content were assumed to be pigment stones. Pigment stones were classified as brown or black according to visual appearance.

Results
Most stones were brown, earthy, and easily crushable. By infrared spectroscopy we found the 61 stones to contain mean 30% cholesterol (range 0–99%), and by the enzymatic assay, 25% (0–96%). The bilirubinate content was 41% (0–100%). In Fig 1 12 stones with varying cholesterol content can be seen. Figure 2 shows the results of infrared spectroscopy.

Cholesterol stones were defined as those containing more than 50% and pigment stones as those containing less than 50% cholesterol respectively. Using this definition 44 stones were of the pigment type. By visual evaluation two stones were black pigment stones. An identical result was achieved by three of the investigators independently. Forty two stones were brown, earthy, and easily crushable. Table I gives demographic data with regard to type of stone. A significant association (p<0.01) was found between juxtapapillary diverticula and pigment stones.

Figure 3 shows the results of the enzymatic cholesterol analysis and the relation between cholesterol content estimated enzymatically and by infrared spectroscopy. Of the 61 stones, 59 were categorised similarly by both methods as either cholesterol or pigment stone.

Eight of 51 patients with the gall bladder intact had no stones in their gall bladder (Table II).

The age distribution (Fig 4) shows the type of stone in different age groups. Cholesterol stones were more frequent in patients below 70 (9 of 17) and pigment stones more frequent above 70 years (35 of 44, p<0.05).

Discussion
In this paper we report the composition of gall stones found in the common duct in patients treated endoscopically. We found that 28% of the gall stones were cholesterol stones, 3% were black pigment stones, and 69% were brown pigment stones. Although no previous study has focused entirely on stones extracted endoscopically, this result is in accordance with the current authoritative view. Nevertheless, some review articles fail to make the distinction between stones in the gall bladder and the common bile duct.

These patients represent a small proportion of patients treated endoscopically in our hospital. About 100 patients with choledocholithiasis are treated in our department each year. For most patients, however, it is not possible both to clear the common duct and to take the stone out with the endoscope. We

**TABLE 1 Characterisation of patients according to stone type**

<table>
<thead>
<tr>
<th></th>
<th>Cholesterol stones (n=17)</th>
<th>Brown pigment stones (n=42)</th>
<th>Black pigment stones (n=2)</th>
<th>Total (n=61)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female/male</td>
<td>10/7</td>
<td>23/19</td>
<td>1/1</td>
<td>34/27</td>
</tr>
<tr>
<td>Juxtapapillary diverticula*</td>
<td>2/2</td>
<td>22/26</td>
<td>2</td>
<td>26</td>
</tr>
<tr>
<td>Previous gastrectomy</td>
<td>2/2</td>
<td>6/8</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Cholecystectomy</td>
<td>3/7</td>
<td>7/10</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Cholecystectomy &gt;2 years</td>
<td>2/5</td>
<td>5/7</td>
<td>0</td>
<td>7</td>
</tr>
</tbody>
</table>

*p<0.01.

![Figure 2: Content of cholesterol and bilirubinate as estimated by infrared spectroscopy, per cent of dry weight. Filled circles represent overlapping measurements and the numbers in parentheses shows the number. Dotted line shows cut-off value for cholesterol stones. The two black pigment stones are circled.](image)

![Figure 3: Content of cholesterol as measured enzymatically and by infrared spectroscopy. y=−0.82x−0.33, r²=0.92. Filled circles represent overlapping measurements and the figure in parentheses shows the number. One black pigment stone is circled, the other is included in ( ), which represents 23 stones.](image)
believe no selection bias has taken place, and the equal rate of gastrectomy, and the similar sex and age distribution support this.

It has been shown that patients with duodenal diverticula often have pigment stones.\textsuperscript{18} This condition can be overlooked and it is often not reported. In our study 26 patients (43\%) had juxtappapillary diverticula. This is in agreement with a recent retrospective study from France,\textsuperscript{25} which reports that 40\% of endoscopy patients with stones in the common bile duct have juxtappapillary diverticula.

Our material consisted of stones collected after endoscopic papillotomy. Most younger patients with common bile duct stones have their stones removed by conventional surgery. As cholesterol stones are more common among younger patients,\textsuperscript{11,21-26} this would indicate that we might have found more cholesterol stones if we had included common bile duct stones treated surgically. Our data confirmed the findings that pigment stones are a feature of older age. Our material is quite small, however, and the association was not very strong.

No systematic investigations for liver disease and haemolysis were undertaken, but none of the patients had clinically known haemolytic or chronic liver disease. Haemolytic disease is rare in Norwegians, and the finding of only two patients with black stones confirms that chronic liver disease and haemolysis is of little importance in our material.

Previous studies suggest that patients treated with a partial gastrectomy run a higher risk of gall stone disease.\textsuperscript{27-29} These stones are generally multiplet and small, and possibly of the pigment type. We found that six of eight stones from patients with a previous gastrectomy were pigment stones. This is in concordance with our material as a whole, and does not explain the comparatively high proportion of pigment stones in this study.

Primary common duct stones, recurring after cholecystectomy are often brown pigment stones.\textsuperscript{12} In our study three of 10 stones recurring after cholecystectomy were cholesterol stones. One of these had been overlooked at surgery and was removed two weeks later. One was a typical cholesterol stone removed three years after cholecystectomy (the stone in the right lower corner of Fig 1). The last one was removed seven years after cholecystectomy. Diverging results from infrared spectroscopy and enzymatic analysis of cholesterol may be the results of different layers in this stone.

It could be speculated that the stone type influences the possibility of losing the stone during the extraction procedure. Cholesterol stones are often smoother and harder. Pigment stones, on the other hand, are softer, and tend to break down when caught in a stone basket. Some stones were lost, which means that the real percentage of pigment stones might have been even higher.

The enzymatic assay introduced by Wei et al\textsuperscript{20} provides a simple and more accessible method for quantification of cholesterol content in gall stones. As in the original study, we found it reliable when compared with the more time consuming and less available infrared spectroscopy.

In many of the stones the main component was neither cholesterol nor bilirubinate. This was not unexpected, as other investigators have found stones with up to 67\% of unidentified material,\textsuperscript{12} even after having measured phosphate, carbonate, palmitate, and calcium in addition to cholesterol and bilirubinate. The wide distribution of cholesterol content may also be a feature of brown common duct stones, as these seem to be the result of precipitation of several different components.

Brown pigment stones were until recently thought to be a rare disease in Western countries. Malet et al\textsuperscript{12} found, however, that a significant proportion of common duct stones in the USA were brown pigment stones. Such stones are probably the result of stasis or infection, or both. This can result from duodenal diverticula, which in this study showed a strong correlation with pigment stones. Duodenal diverticula may lead to growth of \(\beta\)-glucuronidase producing bacteria\textsuperscript{30} and subsequent deconjugation of bilirubinate glucuronides, which leads to pigment precipitation and stone formation.

In conclusion we have shown that brown pigment stones are the commonest stones causing symptomatic bile duct obstruction in a Western population and that cholesterol content of common bile duct stones can adequately be measured enzymatically.

Kjell Windsland, Centre for Industrial Research, Oslo, Norway, performed the infrared spectrophotometry. This work was financially supported by the Anders Jahres Fund.


Common bile duct stones are mainly brown and associated with duodenal diverticula

Common bile duct stones are mainly brown and associated with duodenal diverticula.
O Sandstad, T Osnes, V Skar, P Urdal and M Osnes

*Gut* 1994 35: 1464-1467
doi: 10.1136/gut.35.10.1464

Updated information and services can be found at:
http://gut.bmj.com/content/35/10/1464

**Email alerting service**

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

**Topic Collections**

Articles on similar topics can be found in the following collections
- Stomach and duodenum (1689)
- Pancreas and biliary tract (1949)
- Endoscopy (1003)

**Notes**

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/