The stenosis and/or dilatation of intrahepatic ducts were contributing to the stone formation due to bile stasis. However, the priority of stenosis or dilatation was difficult to decide which one was coming first.

Patients and Methods: Thirty patients of operative intrahepatic stones were encountered in this study. The measurement of left intrahepatic ducts were obtained from the direct choangiogram including the Percutaneous Transhepatic Cholangiography (PTC), Endoscopic Retrograde Cholangiopancreatography (ERCP) and post-operative cholangiogram (POC). The diameter of stenotic portion and dilated portion of intrahepatic ducts with stones were measured before and after removing the stones. The control branch without stones was also carried out in right intrahepatic duct of the same level in the same patient. Results: The diameter of the stenotic portion of intrahepatic duct before removing the stones was 5.10 ± 1.93mm and that of the control branches was 6.50 ± 2.53mm (P>0.05). After removal of the stones, the diameter of stenotic duct were widening to 7.50 ± 2.76 mm with a significant difference from that before removing the stones (P < 0.05 ). The dilated duct was measured about 17.10 ± 5.75mm before removing the stones and became 14.10 ± 4.70 mm with a significant change(P<0.05) after removal of the stones. The ratio of the diameter to stenotic ducts was 3.35 and 1.88mm before and after removal of the stones. Conclusion: After correction of the stenotic portion and complete removal of stones, the dilated duct will improve and become smaller usually. Although the stenotic portion had been improved and stones removed completely, the dilated portion was remained the same in some situations.

Key words: Stenosis of bile duct, Bile duct, Hepatolithiasis

Intrahepatic stone is relatively frequent in Oriental countries and high prevalence in Taiwan [1,2]. Su reported that the incidence of intrahepatic stones was 20% of all gallstone diseases [3]. The patterns of branches and major variation of biliary tract of human had well studied by Healey [4] and Wiechel [5]. Benson and Page [6] had reappraised the anatomy of the extraheptic biliary system by comparing the incidence of various anomalies found in cadaver dissections of calculous and non-calculous subjects with the same findings from an operative and radiological study. Abnormal patterns of intrahepatic ducts had some relationship with the formation of stones in hepatolithiasis was true by Maki [7] and Ker [8]. Therefore, the morphology of intrahepatic ducts seemed very important in the role of pathogenesis of intrahepatic stones.

The stenosis and/or dilatation of intrahepatic ducts were contributing to the bile stasis and stone formation [8,9]. However, the priority of stenosis...
or dilatation was difficult to say which one existed first. In hepatolithiasis, the changes of intrahepatic ducts had been measured by Takahashi [10] and reported the stenotic and dilated portion of intrahepatic duct in hepatolithiasis in seven patients. There was no significance in the difference between the diameter of the stenotic orifice and in control group, but the dilated portion was of significant difference.

This study was conducted for measuring the relationship between the changes of intrahepatic ducts with stenotic and dilated portion before and after removing the intrahepatic stones.

**PATIENTS AND METHODS**

There were thirty patients (M:F = 11:19) of intrahepatic stones were encountered in this study. The ages ranged from 28 to 61 years old. The measurement of intrahepatic ducts were obtained from the direct cholangiogram including the Percutaneous Transhepatic Cholangiography (PTC), Endoscopic Retrograde Cholangiopancreatography (ERCP) and post-operative cholangiogram (POC) which are providing good imaging for studying the stenotic and dilated portion of the intrahepatic ducts. In order to get good image of intrahepatic ducts, only left intrahepatic ducts were studied in this series. The location of intrahepatic stones was usually located at the dilated duct just proximal to the stenotic orifice of left hepatic ducts as shown in the figure 1. All patients were proved to have intrahepatic stones by operative findings and post-operative choledochoscopic lithotripsy.

The diameters of stenotic portion and dilated portion of intrahepatic ducts with stones were measured from the available cholangiogram before and after removing the stones by surgery or postoperative choledochoscopy. The control study of measuring the branch without stone was also carried out at the same level of right intrahepatic duct in the same patient. The period of before and after removing the stones are ranged from 23 to 32 days. The measurement was adjusted by the length of vertebral body of the spine. Therefore, the data we get could reflex the real changes of the difference of the diameters of intrahepatic ducts before and after complete removal of the stones. The data was expressed with mean and standard deviation and Student’s t-test was used for biosstatics analysis. If p-value was less than 0.05, the difference was considered as significant.

**RESULTS**

The diameter of stenotic and dilated portion of the intrahepatic duct with stones was listed as table 1. The results of stenotic portion of intrahepatic duct before removing the stones was 5.10 ± 1.93mm ( mean ± SD ) in diameter and the control branches was 6.50 ± 2.53mm with significant difference. After removal of the stones, the diameter of stenotic duct widened and became 7.50 ± 2.76 mm with a significant difference from that before removing the stones (P < 0.05 ). Concerning the dilated portion with stones, the dilated ducts were measured about 17.10 ± 5.75mm in diameter before removing the stones. After removing the stones, the diameter of the dilated portions were decreased and became 14.10 ± 4.70 mm with a significance difference (P<0.05).

The ratio of the diameter of stenotic and dilated ducts was 3.35 and 1.88 before and after removal of the stones respectively. This alteration was significant as compared with that of control branches (1.05 to 1.07) shown in the table 1. For example, the cystic dilatation of left intrahepatic duct with stones and its orifice was stenotic.

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**Table 1. The diameter of stenotic and dilated portion of the intrahepatic ducts of the patients of intrahepatic stones**

<table>
<thead>
<tr>
<th></th>
<th>Stenosis (mm)</th>
<th>Dilatation (mm)</th>
<th>Pre-D/Pre-S</th>
<th>Post-D/Post/S</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-S</td>
<td>Post-S</td>
<td>Pre-D</td>
<td>Post-D</td>
</tr>
<tr>
<td>Cont</td>
<td>6.56 ± 2.53*</td>
<td>6.33 ± 2.45*</td>
<td>6.89 ± 2.70*</td>
<td>6.78 ± 2.50*</td>
</tr>
<tr>
<td>Path</td>
<td>5.10 ± 1.93*</td>
<td>7.50 ± 2.76*</td>
<td>17.10 ± 4.07*</td>
<td>14.10 ± 4.70*</td>
</tr>
</tbody>
</table>

*1,3,5 P>0.05; *2,4,6 P<0.05 (M ± SD)

Pre-S: Diameter of the stenotic portion before removal of the stones
Post-S: Diameter of the stenotic portion after removal of the stones
Pre-D: Diameter of the dilated portion before removal of the stones
Post-D: Diameter of the dilated portion after removal of the stones
Cont: control duct without stones
Path: pathologic duct with stones
(figure 1). After surgical correction of the stenotic portion and complete removal of stones, the dilated duct decreased its diameter and became smaller finally (figure 2). On the contrary, although the stenotic portion was improved and stones were removed as well, the
dilated portion was remained the same as shown in the figure 3 and 4.

DISCUSSION

What is the stenosis of intrahepatic duct? It’s hard to give the definition for stenosis and is still controversy. In our opinion the stenosis or dilation was defined as comparison in the same hepatic duct. Normally, the diameters of proximal intrahepatic ducts were smaller gradually than those of the distal end. In the patients of intrahepatic stones, the proximal intrahepatic ducts were dilated with the existence of stones, but a smaller diameter of the distal orifice of this duct was a typical findings. In our series, the ratio of dilated and stenotic ducts was 3.35 before removal of stones and became 1.88 after removal of the stones. That means the dilated duct will
decrease its diameter if stones were removed and if stenotic portion had been corrected. From the radiological study of stenotic portion of intrahepatic duct, Takahashi [10] reported 5.5 ± 2.0 mm for stenotic portion with non-significant difference from the control subjects. These results were similar to our series. The stenosis of intrahepatic duct in the patients of hepatolithiasis has been always existed [11, 12]. Therefore, “relative stenosis” was arose due to the dilatation of the duct with stones proximal to the narrow part, so-called stenosis [12, 13]. In our study, it's somewhat wrong to decide whether the stenosis is present or not by radiological study only, because we will neglect the case whose duct is complete obstruction and the contrast media is not allowed to go into the proximal dilated duct with stones. In this situation, the true lesion of stenotic and dilated portion cannot appear in the x-ray film and be recognized and be available for study. However, those conditions will be visible by postoperative choledochoscope sometimes [4, 12, 13]. True pathological lesion will be observed and understood easily in the stenotic duct.

The diameters of stenotic portion were 5.10 ± 1.93 mm and 6.56 ± 2.53 mm in the intrahepatic duct with stones and without stones respectively in the patients of hepatolithiasis. This diameter difference is not significant. It means that the diameter of the orifice of intrahepatic duct with stones could also provide bile drainage as the same as that without stones before the stone formation. Therefore, the true lesion of the distal portion (so-called stenotic portion) is obscure and controversy anyway. However, the stenotic portion will be gradually and widened forcibly by the bigger stone or the high pressure of proximal portion due to long standing of bile stasis. In this situation, the findings of this duct will be overlooked and recognized as normal orifice which can offer the lumen for bile flow. Then, we will neglect the existence of stenosis before the stone formation.

Usually, the condition of stenotic portion will influence the degree of dilated portion in the same bile duct. In our series, the maximal degree for the dilated portion returning to smaller size will be achieved two months after the removal of the stones. Sometimes, the dilated portion never improved even the stones had been removed and the stenotic portion had been corrected. In our experience, the liver parenchymal tissue around the bile duct would influence the capability of the dilated duct returning smaller. If the liver parenchyma was hard in consistency (cirrhotic change), the capacity of recovery was decreased.

According to the flow dynamic theory, the speed of the flow rate in the different diameters of the tube will be changed. If the bile flow started from the dilated proximal portion to the stenotic distal portion, the speed rate will decrease and stagnate before entering the stenotic portion. It is reasonable for bile stasis caused by the different diameters between the dilated and stenotic portions. The ratio of dilated to stenotic portion for control (without stones) and pathologic (with stones) ducts in the patients of hepatolithiasis as shown in the table 1. It means that the larger ratio of dilatation to stenosis will cause bile stasis easier, and be followed by cholangitis which will role the stone formation [12, 15]. In conclusion, we believe that either the stenosis or dilatation of bile duct can contribute to stone formation. Either the stenosis or the dilatation of the intrahepatic ducts will be recovered completely or partially if the pathological conditions were improved. But in some cases, the dilatation still existed even the pathological stenotic lesion had been corrected.

**REFERENCES**

9. Sheen-Chen S, Cheng YF, Chen FC, Chou FF, Lee TY.
肝內結石症之肝內膽管取石前後之變化

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阮綜合醫院 放射科¹ 肝膽外科² 消化內科³

肝內膽管型態與肝內結石形成有相當關係，其肝內膽管擴張或狹窄造成膽汁滯留再形成膽石，然而狹窄或擴張何者事先無法知道。

方法：本研究包括30例肝內結石手術病例，膽管之狹窄或擴張均採左肝管為分析對象，而以相同位置分枝為對照組，其肝內膽管影像均採取1）經皮穿肝膽道造影，2）內視鏡逆行性膽胰管造影，或3）術後膽道鏡造影而來，從這些影像可計算出膽石取出後之狹窄及擴張肝內膽管之變化。結果：肝內結石之膽管狹窄部份與對照膽道分別為5.00±1.93 mm及6.50±2.53 mm，然而擴張肝內膽管之取石前後則為17.10±5.75 mm及14.10±4.70 mm，所以取石後擴張膽管是會改善的。再計算擴張部份與狹窄部份比較有肝石膽管取石前後分別為3.35及1.88可見擴張部份較為改善，而且狹窄部份也改善。結論：肝內結石症之膽管狹窄部份可因手術或取石後而改善，擴張部份也會因取石完整及狹窄改善而縮小，但有些病例雖然狹窄部份改善但擴張依然存在。

關鍵詞：膽汁滯留、膽管、肝內結石症