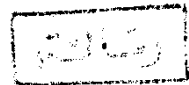


**Relative Values of Ultrasonography,
Computerized Tomography, and Percutaneous
Transhepatic Cholangiography in the Diagnosis
of Surgical Obstructive Jaundice**

Thesis
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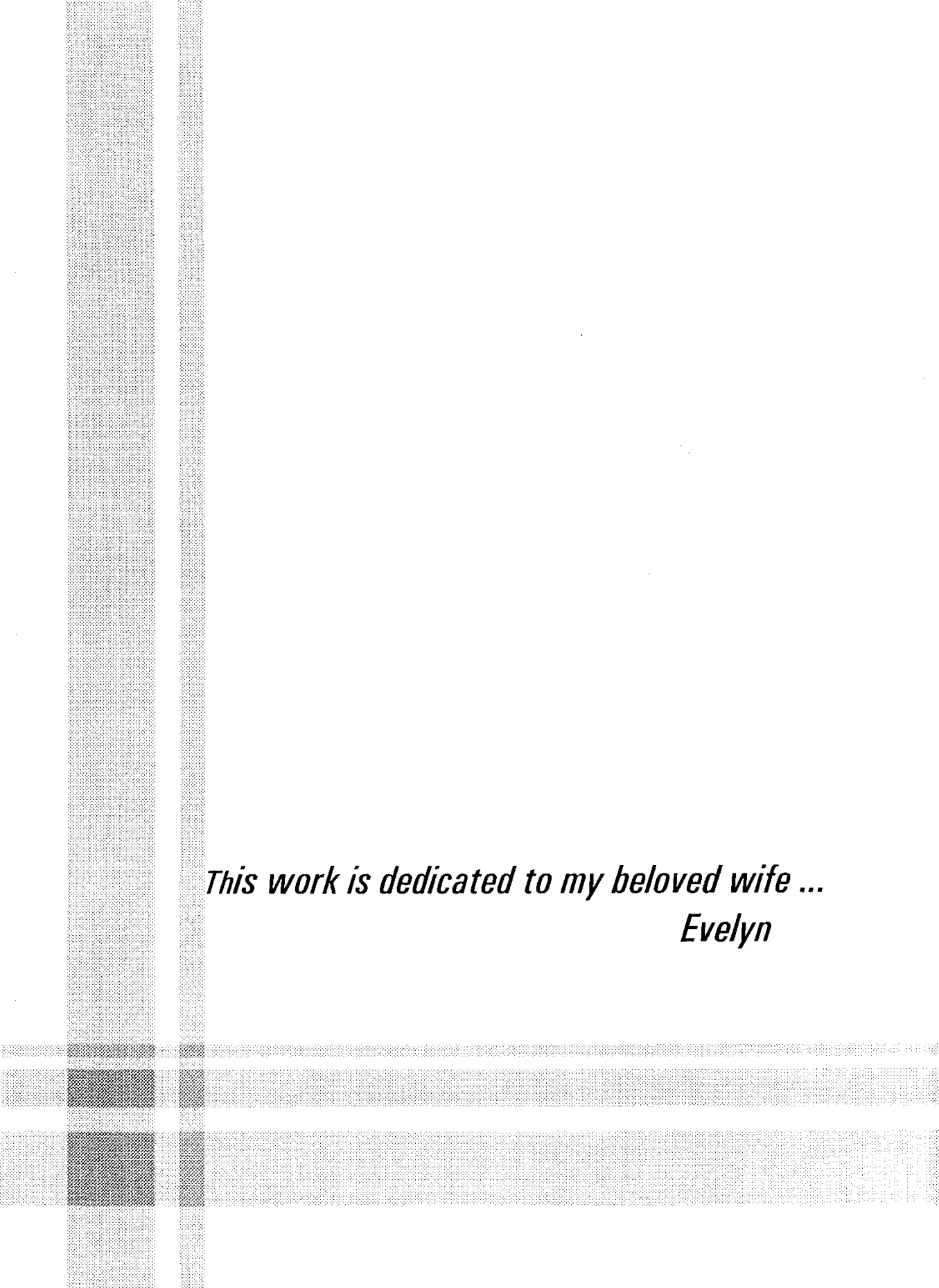
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*This work is dedicated to my beloved wife ...
Evelyn*



Contents

Introduction and Aim of Work	1
Historical Review	3
1 Anatomy of The Biliary Tract	10
2 Physiology of The Biliary System	24
3 Bile Pigments Metabolism , and Jaundice	42
4 Clinical Manifestations of Obstructive Jaundice	53
5 Laboratory Investigations	68
6 Radiologic and Imaging Investigations	80
7 Materials and Methods	155
8 Results	173
9 Discussion	248
10 Conclusion	297
Summary	304
References	307
Arabic Summary .	

**INTRODUCTION
AND
AIM OF WORK**

In the majority of patients with jaundice, the clinical findings and laboratory tests provide enough informations to allow one to distinguish between biliary obstruction and hepatocellular diseases as the cause. Even when the diagnosis of biliary obstruction is certain other tests may be indicated to define the extent, site and nature of the obstruction so that the surgeon can plan for the operation, if needed (Thomas et al., 1982).

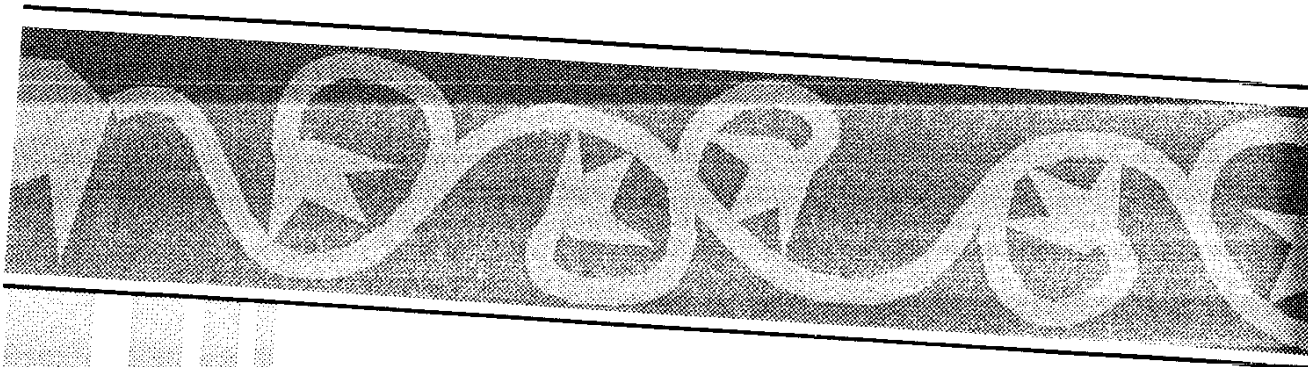
There is a wide spectrum of diagnostic procedures that can be used in case of jaundice. These include the non-invasive scanning methods such as the ultrasonography (US), computed tomography (CT) and isotope scintigraphy. The invasive procedures that can be used for this purpose include the percutaneous transhepatic cholangiography (PTC), percutaneous transhepatic cholangioscopy and ultrasonography. In addition, various endoscopic procedures have been very useful in the diagnosis as well as in the treatment of jaundice. These include the endoscopic retrograde cholangiopancreatography (ERCP), operative choledochoscopy and laparoscopy (Dixit et al., 1993).

Ideally, invasive and expensive diagnostic tests should be ordered stepwise so that each test gives the maximal amount of useful informations. Efficacy as well as accuracy is the major goal. The first question to answer in the differential diagnosis of jaundice is whether duct dilatation is present, since this usually indicates that the jaundice is caused by biliary tract obstruction (Berk et al., 1982).

The aim of this work is to compare between ultrasonography, computerized tomography and percutaneous transhepatic cholangiography in the diagnosis of obstructive jaundice. The value of each test will be studied regarding its accuracy rates in detecting biliary tract obstruction, as

well as the site, extent and cause of obstruction. The findings of these tests will be evaluated according to the operative findings, biopsy examination results, ERCP findings and/or the autopsy examination reports.





HISTORICAL REVIEW



Over the past 50 years much has been learned about the metabolism of bilirubin and the pathophysiology of the jaundice . In particular, during the 1970s numerous advances were made that have totally changed the diagnostic approach and management of jaundiced patients . Among these new and important diagnostic modalities were the intravenous cholangiography (IVC) , ultrasonography (US) , computerized tomography (CT) , thin-needle percutaneous transhepatic cholangiography (PTC) , biliary scintigraphy and magnetic resonance imaging (MRI) . In addition , There are various endoscopic procedures including the endoscopic retrograde cholangiopancreatography (ERCP) , endoscopic ultrasonography (EUS) , choledochoscopy and percutaneous transhepatic cholangioscopy . Several of these diagnostic procedures have also led to newer therapeutic options such as endoscopic papillotomy (EP), endoscopic extraction of CBD stones , endoscopic balloon dilatation and /or placement of an endoprosthesis , percutaneous transhepatic biliary drainage (PTBD) , and percutaneous balloon dilatation of biliary stricture .

In 1953 , **intravenous cholangiography (IVC)** was introduced and was the only method of studying the bile ducts , provided that serum bilirubin levels are less than 3 mg per 100 ml since visualization is not possible when serum bilirubin is above this level (*Rosenquist, 1981*) .

Recently , re-evaluation of IVC and the availability of the other diagnostic techniques have cast serious doubts on the usefulness of this technique . All radiologists can tell from their experience that IVC is decidedly flawed . This can be explained by the considerably high error rates , poor duct visualization and availability of other imaging techniques that offer better visualization of the biliary tract . For these reasons , IVC would seem to be virtually obsolete (*Goodman et al., 1980 and Berk et al., 1982*) .

Ultrasound used for diagnostic purposes was generated and detected by the piezoelectric effect , a process involving the conversion of electric to mechanical energy . This effect was discovered by *J. and P. Curie* in 1880 . The piezoelectric materials are called transducers because they provide a coupling between electrical and mechanical energy . Many naturally occurring crystals are piezoelectric such as quartz and lithium , but the most commonly used material for ultrasonic diagnostic purposes is the synthetic ceramic lead zirconate titanate (**PTZ**) , which belongs to a group of materials known as *the ferroelectrics* .

The primary display mode , introduced in 1972 , was the brightness mode (**B-mode or static display**) which gives a two-dimensional cross-sectional representation of the tissue examined on horizontal and vertical axes . The newer and now almost universally accepted method is the real-time (**gray-scale or bi-dimensional display**) ultrasonography introduced in 1974 . It is performed by means of self-sweeping probe that produces about 40 B-scan images per second so that the examiner receives a moving picture in the same way as the cinema photography (*Taylor et al., 1982*) .

The gray-scale mode has several advantages over the static mode . It is much simpler and its equipment is cheaper . Most importantly , it displays the various kinds of tissue movements such as cardiac contractions and bowel movements and allows the examiner to trace the course of a structure in a process similar to x-ray fluoroscopy (*Cosgrove, 1992*) .

Except for the basic need for a highly trained and skilled examiner , US has many advantages that made it preferred as the first examination of choice for biliary tract diseases . US is non-invasive , it does not imply any ionizing radiations and requires minimal patient's cooperation . In the case

of jaundice . US has been useful in the differentiation between obstructive jaundice and hepatocellular disease and in defining the nature , site and cause of biliary tract obstruction . The sensitivity and specificity of US are now such that patients can proceed directly to operation or to ERCP or PTC for diagnostic confirmation and/or other non-surgical form of management (*Lindsell , 1990*) .

Recently , **endoscopic ultrasound (EUS)** was introduced and is found superior to the conventional US in elucidating the cause of biliary obstruction . It also allows local and regional staging of biliary tract diseases that provides an additional benefit in deciding the appropriate therapy (*Nattermann and Dancygier , 1992*) .

A more recent advance in the ultrasound technology is the *percutaneous intraductal US* . It enables to perform intraluminal sonographic examination of the bile ducts in patients in whom percutaneous transhepatic access has been achieved for diagnostic or therapeutic reasons . This technique is simple and devoid of risks , but requires some refinements and improvements to obtain a wider use in the different clinical problems (*Brambs and Rieber , 1993*) .

Computerized tomography (CT) has been one of the most spectacular advances in medicine during the recent years . This technique was invented by *Sir Godfrey Hounsfield* who was awarded a Nobel Prize in 1979 for this major achievement . The prototype machine was developed by EMI Limited and was installed in the Atkinson Marley's Hospital , London , in 1972 . The success of the brain scanners led to the development of scanners designed to examine the whole body . The first whole body scanner was developed by "Ledley" of Georgetown Medical Center whose work was published in 1974 (*Paxton and Ambrose , 1973*) .

During the last few years, advances in CT technology have lead to fast scanning times and improved image quality. As a result, the scope of CT has advanced enormously that it is now applied to any other anatomical sites. In jaundiced patients, CT plays an important role in the algorithm that leads to the differentiation of the causes of the disease. It can delineate dilated bile ducts, pancreatic masses, liver nodules, retroperitoneal adenopathy in addition to various gastric, splenic and pelvic lesions (*Shea, 1985*).

Endoscopic examination of the duodenum was possible in 1957 (*Hirschowitz et al., 1957*). However, systematic examination of the duodenum was not performed until the period 1968 - 1970 (*Oi et al., 1969*). With the technical improvements in the endoscopic technique, the route for direct cholangiography and pancreatography was opened and this diagnostic method was then widely spread during the period 1970 - 1975. In 1970, the Japanese investigators published preliminary experience with fiberoptic cannulation of the papilla of Vater for the performance of **ERCP** (*Oi, 1989*).

In 1972, the first impacted stone in the ampulla of Vater was removed endoscopically by means of biopsy forceps and in 1973, the diathermy equipment for endoscopic papillotomy was developed in both Germany and Japan. This opened the endoscopic alternative to conventional surgery in patients with CBD stones and endoscopic papillotomy was widely spread during the period from 1979 - 1980 till the present time.

From 1970 till the present time, there have been rapid technical developments in the operator skills, and the appreciation of the pharmacology, anatomy, physiology and radiology of the duodenum, pancreas and biliary tree. These have made ERCP a brief procedure that is now

easily done on an ambulatory basis particularly with the advent of the coloured TV monitors connected to the endoscopic apparatus (*Rosseland and Osnes, 1989*) .

The first report of a **percutaneous transhepatic cholangiography** came from *Huart and Do-Xuan-Hop* in 1937 . However, due to the high incidence of complications such as bile peritonitis and bleeding associated with the use of the wide-bored needles originally used, surgical intervention had to be arranged for immediately after the procedure. In many cases, dilated biliary tree were missed and rarely a non-dilated biliary trees was entered .

This technique was improved with the advent of the image intensifier first reported by *Arnel and Glenn* (1962) . In 1974, *Okuda et al.* introduced the "Chiba" or **skinny** needle, using the lateral approach or PTC which was rapidly accepted as the preferred approach for direct opacification of the biliary tract in the evaluation of cholestatic jaundice (*Teplick et al., 1984*) . The advantage of this technique to the surgeon is to save the operation time by the preoperative localization of the disease in the biliary tract .

In addition, PTC allows various percutaneous procedures such as percutaneous transhepatic biliary drainage (*Savader et al., 1993 - McPherson et al., 1984 - Clouse et al., 1983 - Smith and Temple, 1982 - Mueller et al., 1982 - Kadir et al., 1982*), percutaneous insertion of endoprosthesis (*Pipia et al., 1990 - Okuda et al., 1988 - Yamakawa et al., 1988 - Silander and Thor, 1984*) . percutaneous balloon dilation of biliary strictures (*Vogel et al., 1985 - Teplick et al., 1982*), percutaneous ultrasono-graphy (*Brambs and Rieber, 1993*), and percutaneous transhepatic intra-luminal cholangioscopy (*Salm et al., 1991*) .

Rose bengal sodium I-131, a tetra-iodofluorescein dye introduced about 30 years ago, was the first radio-pharmaceutical used to image the hepato-biliary system. When administered intravenously, this material is bound to plasma proteins, then absorbed by the hepatocytes, secreted in the biliary system, and concentrated like bile in the gallbladder to be finally excreted into the duodenum through the common bile duct (*Handmark, 1975*). In the mid-1970s a new series of ^{99m}Tc-labeled radiopharmaceuticals was developed to image the biliary tract. The introduction of two derivatives of iminodiacetic acid [methyliminodiacetic acid (MIDA) and 2,6-dimethylphenylcarbamoylmethyl iminodiacetic acid (HIDA)] in 1977 was a major step forward in biliary imaging. A variety of ^{99m}Tc iminodiacetic acid derivatives have since been developed, and the technique of cholescintigraphy using these agents has become popular. These agents are superior to rose bengal sodium I-131 because ^{99m}Tc provides a high counting rate, a short half-life of six hours, a relatively low dose of radiation to the patient, and satisfactory imaging of the biliary tree and the gallbladder (*Stadalnik and Hoffer, 1987*).

The phenomenon of **magnetic resonance imaging (MRI)** was developed independently, but almost simultaneously, by *Bloch and Purcell and their colleagues in 1946* and for their discovery they were jointly awarded the Nobel Prize for Physics in 1952 (*Bloch et al., 1946 and Purcell et al., 1946*). Human in-vivo images were first published in 1977 by *Mansfield and Maudsley*. The multiplanar facility of MRI was first demonstrated by *Hawkes et al., 1980*, who reported the first demonstration of intracranial pathology with MRI (*Bradley et al., 1992*).

MR cholangiography has been performed in limited trials and has been found to be a reliable, low-risk investigation that provides a 3D image of

the dilated biliary tree . Being non-invasive , it is suitable for the elderly and ill patients , and in addition it does not possess the complications associated with PTC or ERCP , particularly sepsis and bleeding . Moreover , it provides a more complete visualization of the dilated ducts . However , MRI does not visualize the bile ducts distal to the site of obstruction . Surgical clips , debris and calculi may produce substantial signal dropout in the image (*Hall-Craggs et al., 1993*) .

