

MODERN RADIOLOGY IN THE DIAGNOSIS OF OBSTRUCTIVE JAUNDICE AND LIVER FAILURE WITH MINIMALLY INVASIVE BILE DUCT DRAINAGE

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1. INTRODUCTION

Obstructive jaundice (OJ) remains one of the most clinically significant challenges in hepatopancreatobiliary surgery. It develops primarily as a consequence of biliary obstruction caused by choledocholithiasis, benign biliary strictures, echinococcal cyst rupture into bile ducts, or inflammatory and congenital lesions of the biliary tract. Without timely intervention, OJ leads to progressive hepatic insufficiency, portal hypertension, septic cholangitis, and ultimately multi-organ failure. In Uzbekistan, the incidence of benign obstructive jaundice continues to rise, underscoring the need for refined diagnostic protocols and evidence-based minimally invasive treatment strategies.

Traditional open surgical decompression performed during the acute icteric phase carries a complication rate of 47–68% and a mortality rate of up to 40%. Two-stage treatment, in which minimally invasive decompression precedes definitive reconstruction, has emerged as the internationally preferred approach to reducing perioperative risk. However, optimal selection criteria for endoscopic, percutaneous, and combined techniques remain insufficiently defined, particularly within the Central Asian clinical context. This dissertation addresses that gap.

2. AIM AND OBJECTIVES

The aim of the study is to improve the outcomes of comprehensive treatment in patients with benign obstructive jaundice through the prioritised application of minimally invasive technologies.

The specific objectives were:

To evaluate the role of modern clinical and instrumental diagnostic methods in determining the aetiology of benign obstructive jaundice and to develop a corresponding diagnostic algorithm.

To characterise hepatic haemodynamics by Doppler ultrasonography and correlate the findings with morphofunctional changes in the liver across severity grades of OJ.

To define indications and contraindications for decompressive minimally invasive versus conventional biliary drainage techniques.

To develop differentiated criteria for selecting the timing and method of treatment based on disease severity.

To analyse immediate and long-term outcomes of surgical treatment in patients with benign obstructive jaundice.

3. MATERIAL AND METHODS

The study was conducted at the Departments of Surgery and Radiology of Samarkand State Medical University (SamSMU), based at the multidisciplinary clinic of SamSMU. A total of 424 patients with benign obstructive jaundice treated between 2015 and 2024 constituted the study population. Patients were divided into two groups: the main group (n = 296, treated 2020–2024) in whom a differentiated, stage-based approach with prioritised minimally invasive technologies was applied, and the control group (n = 128, treated 2016–2020) in whom conventional open surgical strategies were used.

Women comprised 67.8% of patients and men 32.2% ($p < 0.001$); the predominant age group was 30–59 years. Disease duration at admission ranged from 1 to 21 days. The most frequent aetiology was choledocholithiasis complicating gallstone disease (47.8%), followed by stenosis of the major duodenal papilla (18.1%), parasitic (echinococcal) jaundice (11.1%), biliary strictures and biliodigestive anastomosis stenosis (7.0%), biliary pancreatitis (4.2%), and Mirizzi syndrome (3.8%). Severity was graded as Class A (43.1%), Class B (37.0%), and Class C (19.9%) according to clinical and laboratory criteria. Liver failure of varying degree was recorded in 48.3% of patients.

Diagnostic methods included general clinical examination, biochemical blood analysis, ultrasound (US), Doppler ultrasonography (DUS), multidetector CT (MDCT), magnetic resonance cholangiopancreatography (MRCP), endoscopic retrograde cholangiopancreatography (ERCP), percutaneous transhepatic cholangiography (PTC), and endoscopic ultrasonography (EUS). Statistical analysis was performed using the χ^2 test, Mann–Whitney U-test, and Kruskal–Wallis H-test.

4. RESULTS

4.1 Diagnostic Algorithm

A stepwise diagnostic algorithm was developed based on the principle of proceeding from non-invasive to invasive modalities. Transabdominal ultrasound was performed in all patients. MRCP was applied in 68 patients with proximal or complex obstruction, achieving a diagnostic accuracy of up to 98% for non-neoplastic biliary

block, confirming its role as a safe non-invasive alternative to ERCP. ERCP was performed in 102 patients of the main group: common bile duct dilatation was detected in 90.1% and intrahepatic duct dilatation in 87.2%; concretions were visualised in 82.4% of procedures. Percutaneous transhepatic cholangiography was reserved for cases in which ERCP was technically unfeasible ($n = 11$). The integrated diagnostic algorithm, implemented in 73.64% of main group patients, enabled rapid determination of the cause, level, and localisation of obstruction, thereby informing pathogenetically justified treatment selection.

4.2 Hepatic Haemodynamics by Doppler Ultrasonography

Doppler studies of hepatic vasculature were performed in 74 patients. In Class B and Class C OJ, maximum portal venous flow velocity was reduced by 1.3-fold (25%) and 1.7-fold respectively compared with normal values, with a concomitant increase in portal vein diameter. The time-averaged maximum velocity (TAMX) was 25% lower in patients with serum bilirubin exceeding $100 \mu\text{mol/L}$. A strong inverse correlation was established between disease severity and portal flow velocity ($r = -0.7$, $p < 0.001$). In the common hepatic artery, V_{max} was 1.52-fold higher in Class C patients relative to controls, with a pulsatility index 5.26 times above normal, indicating compensatory arterialisation of hepatic perfusion. Intraoperative triplex scanning confirmed progressive deterioration of both portal and arterial haemodynamics with advancing OJ severity. These haemodynamic indices are proposed as early predictors of hepatic insufficiency, preceding biochemical changes in serum markers.

4.3 Laboratory Markers of Hepatic Dysfunction

Total bilirubin rose progressively across severity classes: $64.5 \mu\text{mol/L}$ (Class A), $220.6 \mu\text{mol/L}$ (Class B), and $369.9 \mu\text{mol/L}$ (Class C). Parallel elevations in ALT, AST, alkaline phosphatase, and the International Normalised Ratio (INR) were documented. Total plasma protein decreased in Classes B and C (63.0 and 59.4 g/L respectively), reflecting hepatocellular dysfunction. Endogenous intoxication indices, including medium molecular substances and effective albumin concentration, were significantly deranged in severe OJ, consistent with oxidant toxemia and endothelial dysfunction as drivers of hepatic encephalopathy.

4.4 Treatment Outcomes

In the main group ($n = 296$), minimally invasive treatment alone was performed in 158 patients (53.6%): single-stage endoscopic papillosphincterotomy (EPST) with or without lithoextraction or nasobiliary drainage in 102 (34.2%), and two-stage minimally invasive procedures in 56 (18.8%). Combined two-stage approaches

(minimally invasive first, conventional open second) were applied in 60 patients (20.4%). Primary open laparotomy was required in 78 patients (26.4%) due to technical failure of, or complications following, minimally invasive attempts, or anatomical complexity precluding endoscopic access. Minimally invasive decompression failed in 48 patients (16.3%), most commonly due to extended scarring strictures of the major duodenal papilla ($n = 8$), hepaticojejunostomy stenosis ($n = 10$), and impacted calculi.

Overall, the differentiated approach in the main group yielded a postoperative complication rate of 19.5% and a mortality rate of 4.05%, compared with 26.6% and 6.5% respectively in the control group. Long-term (6 months to 5 years) good results were achieved in 88.7% of patients treated by minimally invasive methods, 78.0% after combined two-stage procedures, and 70.0% after primary open surgery. Quality of life in the main group was superior to that in the control group across all outcome measures.

5. CONCLUSIONS

1. Diagnosis of benign OJ must be comprehensive, employing the developed stepwise algorithm integrating non-invasive imaging (US, MRCP) with invasive modalities (ERCP, PTC) and transitioning directly to biliary decompression; this approach was successfully executed in 73.64% of main group patients.

2. Doppler ultrasonography of hepatic vasculature revealed a 1.3-fold and 1.7-fold reduction in maximum portal venous flow velocity in Class B and Class C OJ respectively, with portal vein dilatation and a 25% decrease in TAMX at bilirubin concentrations exceeding $100 \mu\text{mol/L}$, establishing these parameters as early predictors of hepatic insufficiency.

3. Class B and Class C OJ constitutes an indication for initial minimally invasive decompression (EPST with nasobiliary drainage, or percutaneous transhepatic cholangiostomy under ultrasound guidance); when EPST is unfeasible (16.21%), antegrade echo-guided intervention is the preferred first-stage modality, with radical correction deferred until stabilisation to Class A or B.

4. Selection of the decompressive technique must follow a strictly differentiated algorithm: single-stage minimally invasive procedure (34.45%), two-stage minimally invasive procedure (13.20%), or combined minimally invasive and open approach (20.27%); open laparotomy remains the preferred option in cases of minimally invasive failure, complications, or long-segment biliary strictures.

5. Application of differentiated surgical tactics combining pathogenetically justified minimally invasive decompression with open reconstructive procedures

reduced postoperative complications from 26.6% to 19.5% and mortality from 6.5% to 4.05% compared with the conventional open approach.

6. SCIENTIFIC NOVELTY

For the first time, Doppler haemodynamic indices of the portal vein and common hepatic artery were proposed as objective early predictors of hepatic insufficiency and cholangitis severity in OJ, preceding biochemical markers. A novel diagnostic algorithm was developed and validated in a cohort of 424 patients. Evidence-based criteria for selecting single-stage, two-stage, and combined minimally invasive decompression were established. A differentiated classification of OJ severity (Classes A, B, C) was refined and linked to specific treatment pathways, enabling individualised decision-making.