Supplementary Table 1 Evaluation criteria for image quality

Overall Rating	Image quality evaluation criteria
Excellent: Image quality is excellent and conducive to surgery.	-There are even illuminations in the center and edges of the image, and the layering is very clear. -Morphology, borders and color of biliary mucosal microvessels are very clear and highly visible. -Morphology, borders and color of biliary lesions such as stones are very clear and highly visible. -Matched endoscopic accessories are very clear and highly visible.
Good: Image quality is good and suitable for surgery.	-There are even illuminations in the center and edges of the image, and the layering is very clear. -Morphology, borders and color of biliary mucosal microvessels are clear and normally visible. -Morphology, borders and color of biliary lesions such as stones are clear and normally visible. -Matched endoscopic accessories are very clear and normally visible.
Ordinary**:** Image quality is ordinary but it does not affect surgery.	-There are even illuminations in the center and edges of the image, and the layering is acceptable. -Morphology, borders and color of biliary mucosal microvessels are relatively clear and normally acceptable. -Morphology, borders and color of biliary lesions such as stones are relatively clear and normally acceptable. -Matched endoscopic accessories are relatively clear and normally acceptable.

Poor: Image quality is poor and it affects surgery.	-Illuminations in the center and edges of the image are not even, and the layering is poor. -Morphology, borders and color of biliary mucosal microvessels are poorly visible and recognizable. -Morphology, borders and color of biliary lesions such as stones are poorly visible and recognizable. -Matched endoscopic accessories are poorly visible and recognizable.
Very Poor: Image quality is very poor and cannot be used for surgery.	-Illuminations in the center and edges of the image are fairly uneven, and the layering is very poor. -Morphology, borders and color of biliary mucosal microvessels are poorly visible and unrecognizable. -Morphology, borders and color of biliary lesions such as stones are poorly visible and unrecognizable. -Matched endoscopic accessories are poorly visible and unrecognizable.

Supplementary Table 2 Evaluation criteria for cholangioscopy performance

Performance metrics	1	2	3	4	5
Insertion	Unable to insert the cholangioscope	Difficult insertion	suboptimal insertion	Normal insertion	Smooth insertion
Withdrawal	Unable to withdraw the cholangioscope	Difficult withdrawal	suboptimal withdrawal	Normal withdrawal	Smooth withdrawal
Sealing	Severe leakage, unable to visualize surgical field or perform the operation	Significant leakage, severely affects visualization and operation	Mild leakage, able to visualize surgical field but operation is compromised	No leakage, normal visualization and operation	-
Angulation	Bending section cannot bend or fails to return	Bending section has limited bending or return	Bending section has mild limited bending or return	Bending section can bend and return to a normal position	Bending section can bend and return smoothly
Accessory insertion and withdrawal	Unable to insert or withdraw through the	Difficult insertion or withdrawal through the	Slightly difficult insertion or withdrawal	Normal insertion or withdrawal through the	Smooth insertion or withdrawal through the

	accessory channel	accessory channel	through the accessory channel	accessory channel	accessory channel
Accessory compatibility	Accessory cannot work with the instrument channel to complete the procedure	Difficulty in coordination between accessory and the instrument channel	Slight difficulty in coordination between accessory and the instrument channel	Normal coordination between accessory and the instrument channel	Smooth coordination between accessory and the instrument channel