Clinical Interventions in Aging

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ORIGINAL RESEARCH

Efficacy and Safety of Endoscopic Retrograde Cholangiopancreatography for the Longevous Population

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Background: There are presently limited clinical studies of endoscopic retrograde cholangiopancreatography (ERCP) in the longevous (elders aged no less than 90 years old). This study aimed to evaluate the efficacy and safety of ERCP in longevous patients.

Methods: A total of 113 longevous patients who underwent ERCP for the first time at our center from January 8th, 2009 to December 20th, 2023 were enrolled. Correspondingly, the control groups included the old-old (75–89 years) patient group and the young-old (60–74 years) patient group. Each of the control group was matched in a 1:2 ratio to the longevous patient group based on the gender, presence of choledocholithiasis, endoscopic sphincterotomy, endoscopic papillary balloon dilatation, periampullary diverticulum, the placement of biliary stent, and guidewire entry into the pancreatic ducts, ultimately including 226 patients in each control group. Baseline characteristics, clinical and endoscopic data were compared among the three groups, and risk factors for post-ERCP pancreatitis in elderly patients were analyzed.

Results: Except for the higher incidence of acute cholangitis and atrial fibrillation (AF) in longevous patients, the three elderly patient groups were comparable in baseline characteristics. The technical success rate of ERCP in longevous patients was 95.6%, which has no significant difference from that of old-old patients (95.1%) and young-old patients (96.9%) during the same period. The overall incidence of post-ERCP adverse events was 12.9%, and there was no significant difference in the incidence and mortality of adverse events among the three groups. PEP was the most common adverse event after ERCP in elderly patients. Multivariable logistic regression analysis showed endoscopic metal biliary endoprothesis (OR=2.351, 95% CI 1.144–4.832, P=0.020), pancreatic duct opacification (OR=5.774, 95% CI 1.062–31.383, P=0.042) were independent risk factors for PEP in elderly patients.

Conclusion: ERCP is safe and effective in the longevous population, and advanced age did not increase the incidence of adverse events after ERCP.

Keywords: the longevous, endoscopic retrograde cholangiopancreatography, efficacy, safety, risk factors

Introduction

Endoscopic retrograde cholangiopancreatography (ERCP) has been an important method for diagnosis and therapy of various pancreaticobiliary disorders.[1,2] With the increase of average life expectancy, the incidence of biliary and pancreatic diseases in the elderly increases significantly, especially common bile duct (CBD) stones and pancreaticobiliary malignant tumors.[3,4] The World Health Organization (WHO) defines the population over 90 years old as the longevous,[5] and this elderly population has unique characteristics compared with patients of other elderly groups. The longevous have an insidious onset of disease and atypical clinical manifestations, which often delay diagnosis and may even lead to severe complications. At the same time, the longevous often have more underlying diseases and poor nutritional status. In addition, the function of important organs in the longevous has declined significantly. Therefore,

Received: 18 May 2025
Accepted: 14 October 2025
Published: 1 November 2025

most longevous patients are reluctant or intolerant to surgery.[6,7] Compared with surgery, ERCP has the advantages of less trauma, faster postoperative recovery, shorter operation time, and relatively lower medical costs.[8] Therefore, therapeutic ERCP may be the preferred treatment for the longevous with limited life expectancy.

Nowadays, there have been several reports[9–11] on therapeutic ERCP for biliary and pancreatic diseases in elderly patients, including comparative studies by Yang et al (≥80 years old vs ≤65 years old),[9] Fritz et al (≥80 years old vs <80 years old),[10] Galeazzi et al (65–79 years old vs ≥80 years old).[11] These studies indicated that although elderly patients have relatively more comorbidities, ERCP is a safe and effective in elderly population. While these findings provide important references for the perioperative assessment of ERCP in elderly patients, most of them are confined to comparisons between old-old patients and young-old patients, lacking detailed comparisons among the longevous population and other elderly populations. Zhang et al[12] compared longevous patients with patients aged 85–89 years. However, the sample size of their study was small and no comparison concerning the other elderly patients such as young-old patients was performed. Currently, the efficacy, safety, and risk factors for adverse events in the longevous undergoing ERCP have not been fully elucidated. In this study, we collected the clinical data of 113 cases of the longevous who underwent their first ERCP in our hospital in the past almost 15 years and compared them with the old-old (75–89 years old) and the young-old (60–74 years old) who underwent their first ERCP during the same period. The potential clinical impact of such comparative findings is to help clinician recognize the efficacy and safety of ERCP in longevous patients.

Materials and Methods

Patients

This study was a single-center retrospective observational study and strictly adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. A total of 113 longevous patients (≥ 90 years old) who underwent their first ERCP at the Gastrointestinal Endoscopy Center of the First Affiliated Hospital of Nanchang University from January 2009 to December 2023 were enrolled. Correspondingly, the control groups included the old-old (75–89 years) patient group and the young-old (60–74 years) patient group. Each of the control group was matched to the longevous patient group in a 1:2 ratio based on the gender, presence of choledocholithiasis, endoscopic sphincterotomy (EST), endoscopic papillary balloon dilatation (EPBD), periampullary diverticulum (PAD), the placement of biliary stent, and guidewire entry into the pancreatic ducts, ultimately including 226 patients in each control group. The patient's clinical data and ERCP reports were collected, including baseline characteristics, laboratory indicators, technical success rate, intraoperative diagnosis, intervention methods, and ERCP-related adverse events. We compared the technical success rate of ERCP, the changes in laboratory indicators before and after ERCP, and the incidence and severity of post-ERCP adverse events among the three groups (Figure 1). Further, we also analyzed the risk factors for PEP in elderly patients.

The inclusion criteria of this study were as follows: (1) age ≥ 60 years old, regardless of gender; (2) preoperative clinical diagnosis of biliary or pancreatic diseases and the presence of ERCP indications; (3) All patients signed the informed consent forms and received ERCP procedures. Patients with incomplete clinical data or missed follow-up were excluded. This study was approved by the Medical Research Ethics Committee of the First Affiliated Hospital of Nanchang University (No.2024096) and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Definitions

Technical success was defined as the achievement of deep cannulation for diagnostic and/or therapeutic ERCP.[13] Complete stone extraction in one session was defined as complete clearance of CBD stones in only one ERCP procedure. ERCP-related adverse events and their severity grading were classified according to the European Society of Gastrointestinal Endoscopy (ESGE) Guideline.[14] Cardiopulmonary adverse events include myocardial infarction, cerebrovascular accident, congestive heart failure, cardiac/respiratory arrest, arrhythmia, hypoxemia, hypotension, etc.[11] The age segmentation by WHO was as follows: elderly aged ≥90 years were the longevous, elderly aged 75–89 years were the old-old, and 60–74 years were the young-old.[5] The physical status classification of the patients was determined according to the standard by the American Society of Anesthesiologists (ASA) classification.[15]

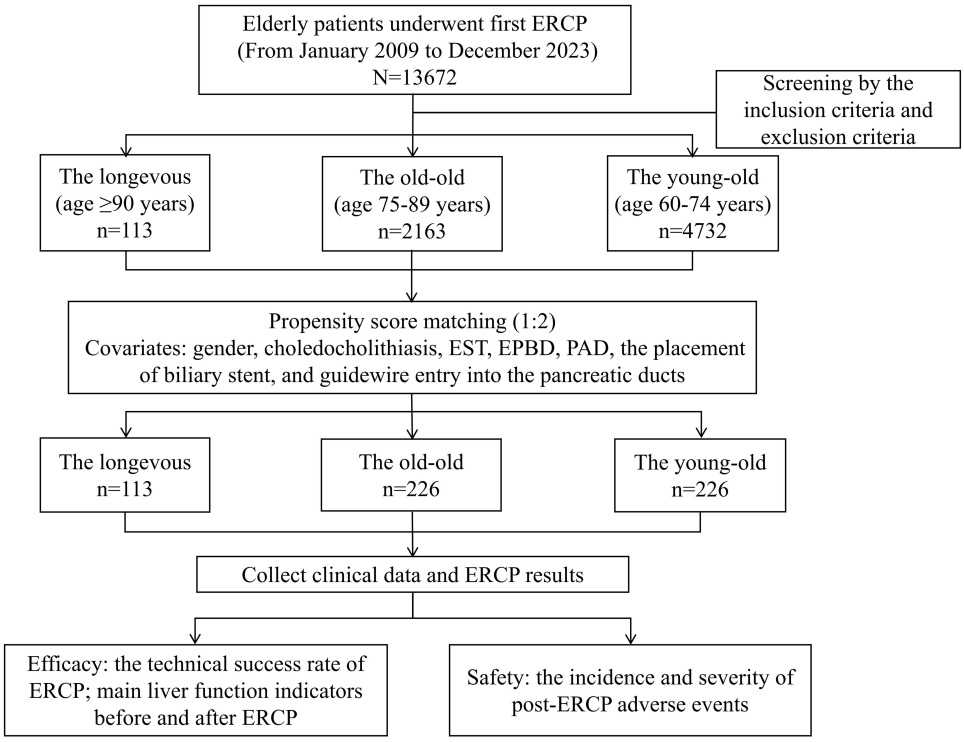

Figure 1 Flow chart of the study.
Abbreviations: ERCP, endoscopic retrograde cholangiopancreatography; EST, endoscopic sphincterotomy; EPBD, endoscopic papillary balloon dilatation; PAD, periampullary diverticulum.

Procedures

The indications and contraindications of ERCP were strictly evaluated preoperatively. Patients were fully informed of the purpose, methods, and risks associated with the ERCP and signed the informed consent form. Patients with no contraindications of nonsteroidal anti-inflammatory drugs (NSAIDs) receive rectal administration of diclofenac before ERCP. All ERCP procedures were performed by experienced endoscopists. The JF-260V or TJF-260V electronic duodenoscopy and related accessories manufactured by Olympus Corporation from Japan were used for ERCP. The patients were placed in the prone position during the operation, and the supine position was used for intolerance or other exceptional cases. According to the assessment of the patients' condition, the anesthesiologist used simple general anesthesia or general anesthesia under endotracheal intubation, with continuous oxygen and cardiopulmonary monitoring during the entire operation. Appropriate operating instruments were adopted according to the actual intraoperative situation. After ERCP, alarm symptoms such as abdominal pain, abdominal distension, fever, vomiting blood or black stools, etc were monitored. Serum amylase at three hours and the blood routine, liver function, and serum amylase at 24 hours after ERCP were tested. The patients were routinely fasted for 24 hours after ERCP procedures. If ERCP-related adverse events occur, the fasting time should be prolonged, and appropriate treatment should be given accordingly. After the patient was discharged, a follow-up period of at least 3 months was performed.

Statistical Analysis

Statistical analysis was performed using SPSS 26.0 software (IBM Corp., New York, USA). Missing data were handled using multiple imputation. Categorical variables were described with percentages (%) and were analyzed with the $\chi 2$ test or Fisher's exact test. The quantitative data with normal distribution were expressed as mean±standard deviation (M±SD) and were analyzed using one-way ANOVA. Quantitative data with non-normal distribution were expressed as the median and interquartile range (IQR) and were analyzed using the Kruskal–Wallis *H*-test. The Bonferroni correction was used to make multiple comparisons among different groups. The laboratory indicators before and after ERCP were analyzed with

https://doi.org/10.2147/CIA.S541278

repeated measures analysis of variance. The analysis of risk factors for PEP in elderly patients was performed using univariate and multivariate logistic regression models. P <0.05 was considered statistically significant.

Results

Baseline Characteristics

This study totally included 565 elderly patients, including 113 longevous patients, 226 old-old patients, and 226 young-old patients. The most common symptoms in the three groups of elderly patients were abdominal pain and distension, followed by jaundice, nausea, vomiting, and fever. The most common clinical diagnosis of the three elderly groups was choledocholithiasis. The incidence of acute cholangitis (44.2%) in the longevous group was the highest among the three groups, with a significant difference (P=0.000), while there was no significant difference in the other diagnoses among the three groups (P>0.05). In terms of comorbidities, except for a significant difference in the incidence of atrial fibrillation (AF) between the longevous and young-old group (P<0.05), there was no significant difference in the other comorbidities and the use of antiplatelet or anticoagulant drugs among the three groups (P>0.05). To sum up, except for age, acute cholangitis, and AF, there was no significant difference in the baseline characteristics among the three groups (P>0.05) (Table 1).

Table 1 Baseline Characteristics of the Study Groups

	The Longevous (n=113)	The Old-Old (n=226)	The Young-Old (n=226)	*P* Value
Age	92.12±2.26[a]	79.71±3.87[b]	66.96±4.38[c]	0.000
Male	59 (52.2%)	118 (52.2%)	118 (52.2%)	1.000
Clinical manifestation				
Abdominal pain and distension	91 (80.5%)	191 (84.5%)	200 (88.5%)	0.135
Nausea and vomiting	61 (54.0%)	96 (42.5%)	110 (48.7%)	0.116
Fever	51 (45.1%)	82 (36.3%)	74 (32.7%)	0.082
Jaundice	69 (61.1%)	121 (53.5%)	115 (50.9%)	0.205
Clinical diagnosis				
Choledocholithiasis	87 (77.0%)	157 (69.5%)	157 (69.5%)	0.289
Acute cholangitis	50 (44.2%)[a]	61 (27.0%)[b]	49 (21.7%)[b]	0.000
Acute biliary pancreatitis	12 (10.6%)	15 (6.6%)	28 (12.4%)	0.112
Bile duct stenosis	25 (22.1%)	51 (22.6%)	63 (27.9%)	0.335
Cholangiocarcinoma	12 (10.6%)	25 (11.1%)	22 (9.7%)	0.897
Gallbladder cancer	2 (1.8%)	3 (1.3%)	3 (1.3%)	1.000
Pancreatic cancer	7 (6.2%)	9 (4.0%)	8 (3.5%)	0.504
Duodenal papilla cancer	4 (3.5%)	9 (4.0%)	11 (4.9%)	0.822
Periampullary carcinoma	1 (0.9%)	2 (0.9%)	1 (0.4%)	1.000
Comorbidity				
Diabetes	8 (7.1%)	24 (10.6%)	26 (11.5%)	0.438
Hypertension	38 (33.6%)	85 (37.6%)	61 (27.0%)	0.053
Coronary heart disease	7 (6.2%)	15 (6.6%)	9 (4.0%)	0.433
Atrial fibrillation	9 (8.0%)[a]	12 (5.3%)[a,b]	5 (2.2%)[b]	0.047
Cerebrovascular disease	5 (4.4%)	13 (5.8%)	8 (3.5%)	0.530
COPD/Asthma	6 (5.3%)	5 (2.2%)	4 (1.8%)	0.140
Liver cirrhosis	4 (3.5%)	6 (2.7%)	13 (5.8%)	0.237
History of pancreatitis	5 (4.4%)	10 (4.4%)	6 (2.7%)	0.552
Chronic renal failure	1 (0.9%)	1 (0.4%)	1 (0.4%)	1.000
Malignant tumor	10 (8.8%)	11 (4.9%)	11 (4.9%)	0.261
Dementia	1 (0.9%)	3 (1.3%)	1 (0.4%)	0.845
Digestive tract reconstruction	3 (2.7%)	10 (4.4%)	7 (3.1%)	0.635
Antithrombotic or anticoagulant drugs	9 (8.0%)	12 (5.3%)	9 (4.0%)	0.305

(*Continued*)

Table 1 (Continued).

	The Longevous (n=113)	The Old-Old (n=226)	The Young-Old (n=226)	*P* Value
ASA physical status classification				
Grade II	71 (62.8%)	154 (68.1%)	163 (72.1%)	0.215
Grade III	39 (34.5%)	69 (30.5%)	61 (27.0%)	0.350
Grade IV	3 (2.7%)	3 (1.3%)	2 (0.9%)	0.472

Notes: The superscript letters (a, b, c) shown in the same row of the table represent the results of multiple comparisons when there is a significant difference in a certain indicator among the three groups. If the superscript letters of two groups in the same row contain the same letter, it indicates that there is no statistical difference between the two groups. Conversely, if the superscript letters of two groups in the same row are completely different, it indicates that there is a statistical difference between them.
Abbreviations: COPD, chronic obstructive pulmonary disease; ASA, American Society of Anesthesiologists.

Procedures

The technical success rate of the first ERCP in the longevous group was 95.6% (108/113) and had no statistical difference ($P>0.05$) compared with that of the old-old group (95.1%, 215/226) and young-old group (96.9%, 219/226). In terms of ERCP intraoperative diagnosis, choledocholithiasis was the most common diagnosis in elderly patients, with the highest ratio of patients with CBD stones diameter ≥1 cm in the longevous group (74.7%, 65/87) ($P<0.05$). However, there was no significant difference in intraoperative diagnosis among the three groups ($P>0.05$). In terms of ERCP intervention methods, there were significant differences in mechanical lithotripsy, EPBD, and endoscopic nasobiliary drainage (ENBD) among the three groups ($P<0.05$), with the highest mechanical lithotripsy rate (8.8%), EPBD rate (46.9%) and the lowest ENBD rate (16.8%) in the longevous group, while the other intervention methods were no significant difference among the three groups ($P>0.05$) (Table 2).

Table 2 ERCP-Related Findings and Procedures Among the Three Groups

	The Longevous (n=113)	The Old-Old (n=226)	The Young-Old (n=226)	*P* Value
Technical success rate	108 (95.6%)	215 (95.1%)	219 (96.9%)	0.621
ERCP diagnosis				
Choledocholithiasis	87 (77.0%)	157 (69.5%)	157 (69.5%)	0.289
Maximum diameter of stones (mm)				
<5	6(6.9%)[a]	28 (17.8%)[a,b]	39 (24.8%)[b]	0.002
5–9	16 (18.4%)	48 (30.6%)	46 (29.3%)	0.099
10–14	38 (43.7%)[a]	39 (24.8%)[b]	41 (26.1%)[b]	0.004
≥15	27 (31.0%)	42 (26.8%)	31 (19.9%)	0.119
Number of stones				
Single/sedimentary stones	32 (36.8%)	70 (44.6%)	80 (51%)	0.100
≥2	55 (63.2%)	87 (55.4%)	77 (49%)	0.100
Stone entrapment in papilla	4 (3.5%)	11 (4.9%)	7 (3.1%)	0.609
Pyogenic cholangitis	15 (13.3%)	24 (10.6%)	21 (9.3%)	0.533
Chronic pancreatitis	0 (0)	1 (0.4%)	1 (0.4%)	1.000
Mirrizi syndrome	0 (0)	1 (0.4%)	1 (0.4%)	1.000
Pancreatic pseudocyst	0 (0)	0 (0)	1 (0.4%)	1.000
Periampullary diverticulum	62 (54.9%)	124 (54.9%)	127 (56.2%)	0.953
Duodeno-biliary fistula	3 (2.7%)	6 (2.7%)	5 (2.2%)	0.947
Duodenal papillary adenoma	0 (0)	0 (0)	1 (0.4%)	1.000
Ectopic duodenal papilla	1 (0.9%)	0 (0)	1 (0.4%)	0.679
Biliary ascariasis	0 (0)	1 (0.4%)	1 (0.4%)	1.000
Duodenal papilla cancer	4 (3.5%)	9 (4.0%)	11 (4.9%)	0.822
Periampullary carcinoma	1 (0.9%)	2 (0.9%)	1 (0.4%)	1.000
Sclerosing cholangitis	0 (0)	1 (0.4%)	3 (1.3%)	0.537

(*Continued*)

Table 2 (Continued).

	The Longevous (n=113)	The Old-Old (n=226)	The Young-Old (n=226)	*P* Value
IgG4-related cholangitis	0 (0)	1 (0.4%)	1 (0.4%)	1.000
Cholangiomyxoma	0 (0)	1 (0.4%)	2 (0.9%)	0.807
Esophageal and gastric varices	1 (0.9%)	2 (0.9%)	7 (3.1%)	0.178
Inflammatory bile duct stenosis	4 (3.5%)	10 (4.4%)	20 (8.8%)	0.066
Malignant bile duct stenosis	21 (18.6%)	41 (18.1%)	43 (19.0%)	0.971
Cholangiectasis	0 (0)	1 (0.4%)	1 (0.4%)	1.000
Interventions				
CBD stones removal	75 (66.4%)	127 (56.2%)	133 (58.8%)	0.196
Complete stone extraction in one session	66 (75.9%)	120 (76.4%)	129 (82.2%)	0.366
Mechanical lithotripsy	10 (8.8%)[a]	12 (5.3%)[a,b]	4 (1.8%)[b]	0.011
Pre-cut	10 (8.8%)	12 (5.3%)	14 (6.2%)	0.449
EST	80 (70.8%)	163 (72.1%)	159 (70.4%)	0.913
EPBD	53 (46.9%)[a]	57 (25.2%)[b]	45 (19.9%)[b]	0.000
ENBD	19 (16.8%)[a]	64 (28.3%)[a,b]	82 (36.3%)[b]	0.001
ERBD	57 (50.4%)	106 (46.9%)	105 (46.5%)	0.770
EMBE	17 (15%)	41 (18.1%)	36 (15.9%)	0.720
ERPD	15 (13.3%)	20 (8.8%)	19 (8.4%)	0.319
Bougienage	1 (0.9%)	12 (5.3%)	6 (2.7%)	0.077
Biopsy	6 (5.3%)	22 (9.7%)	21 (9.3%)	0.360
Cytobrush	2 (1.8%)	12 (5.3%)	16 (7.1%)	0.121
Guidewire into pancreatic duct (times)				
0	98 (86.7%)	202 (89.4%)	196 (86.7%)	0.640
1	9 (8.0%)	13 (5.8%)	15 (6.6%)	0.738
≥2	6 (5.3%)	11 (4.9%)	15 (6.6%)	0.706

Notes: The superscript letters (a, b) shown in the same row of the table represent the results of multiple comparisons when there is a significant difference in a certain indicator among the three groups. If the superscript letters of two groups in the same row contain the same letter, it indicates that there is no statistical difference between the two groups. Conversely, if the superscript letters of two groups in the same row are completely different, it indicates that there is a statistical difference between them.
Abbreviations: ERCP, endoscopic retrograde cholangiopancreatography; IgG4, Immunoglobulin G4; CBD, common bile duct; EST, endoscopic sphincterotomy; EPBD, endoscopic papillary balloon dilatation; ENBD, endoscopic nasobiliary drainage; ERBD, endoscopic retrograde biliary drainage; EMBE, endoscopic metal biliary endoprothesis; ERPD, endoscopic retrograde pancreatic drainage.

The Laboratory Indicators

The post-ERCP liver function indicators of alanine aminotransferase (ALT), aspartate aminotransferase (AST), total bilirubin (TBIL), and direct bilirubin (DBIL) in all three groups were significantly improved compared with pre-ERCP indicators ($P<0.05$). There was no significant difference in liver function indicators such as ALT, AST, TBIL, and DBIL among the three groups of elderly patients ($P>0.05$) (Table 3).

Adverse Events

The overall incidence of post-ERCP adverse events was 12.9% (73/565), with 12.4% (14/113) in longevous patients, 13.3% (30/226) in the old-old, and 12.8% (29/226) in the young-old. There was no significant difference in the incidence and mortality of ERCP-related adverse events among the three elderly groups ($P>0.05$). PEP was the most common post-ERCP adverse event, with an overall incidence rate of 7.1% (40/565), and the incidence rates of PEP in the three groups of elderly patients were 5.3%, 7.5%, and 7.5%, respectively, with no significant difference ($P>0.05$). There was one patient death in each of the longevous and young-old groups, but the cause of death was multiple organ failure due to primary diseases rather than ERCP itself. Totally four cases of perforation were found during ERCP procedures; one patient had duodenal diverticulum perforation, which recovered after endoscopic treatment, and the other three patients with duodenal perforation were transferred to surgery. Patients with post-ERCP pancreatitis, bleeding, biliary infection, and other complications were recovered with appropriate treatments (Table 4).

Table 3 The Main Laboratory Indicators of Liver Function Before and After ERCP Among the Three Groups

Indicators	Time	The Longevous (n=113)	The Old-Old (n=226)	The Young-Old (n=226)	*P*1	*P*2	*P*3
ALT (U/L)	Pre-ERCP	96.81±103.34	96.43±113.73	105.46±104.26	0.000	0.211	0.772
	Post-ERCP	63.45±66.48	70.70±70.96	68.74±67.81			
	*P*4	0.000	0.000	0.000			
AST (U/L)	Pre-ERCP	111.63±116.19	106.07±160.56	95.13±119.21	0.000	0.551	0.255
	Post-ERCP	73.46±91.15	81.47±83.31	62.82±76.61			
	*P*4	0.000	0.002	0.000			
TBIL (umol/L)	Pre-ERCP	97.49±113.14	95.89±114.85	87.93±109.78	0.000	0.996	0.629
	Post-ERCP	84.24±101.46	82.14±97.44	74.18±96.04			
	*P*4	0.001	0.001	0.000			
DBIL (umol/L)	Pre-ERCP	67.42±82.76	64.28±79.28	60.18±79.44	0.000	0.346	0.499
	Post-ERCP	64.52±85.23	54.39±72.42	51.20±69.64			
	*P*4	0.011	0.001	0.001			

Notes: *P*1 value, integrated comparison between pre-ERCP and post-ERCP laboratory indicators in the three groups; *P*2 value, interaction effect between the group factor (the longevous group, the old-old group and the young-old group) and the time factor (pre-ERCP and post-ERCP); *P*3 value, comparison among the three groups for both pre-ERCP and post-ERCP; *P*4 value, paired comparison between pre-ERCP and post-ERCP in each group.

Abbreviations: ERCP, endoscopic retrograde cholangiopancreatography; ALT, alanine aminotransferase; AST, aspartate aminotransferase; TBIL, total bilirubin; DBIL, direct bilirubin.

Table 4 ERCP-Related Adverse Events Among the Three Groups

	Total	The Longevous (n=113)	The Old-Old (n=226)	The Young-Old (n=226)	*P* Value
Pancreatitis	40 (7.1%)	6 (5.3%)	17 (7.5%)	17 (7.5%)	0.714
Mild	37 (92.5%)	6 (100%)	16 (94.1%)	15 (88.2%)	1.000
Moderate	1 (2.5%)	0 (0)	0 (0)	1 (5.9%)	1.000
Severe	2 (5.0%)	0 (0)	1 (5.9%)	1 (5.9%)	1.000
Bleeding	2 (0.4%)	0 (0)	2 (0.9%)	0 (0)	0.359
Perforation	4 (0.7%)	1 (0.9%)	1 (0.4%)	2 (0.9%)	1.000
Biliary infection	25 (4.4%)	5 (4.4%)	9 (4.0%)	11 (4.9%)	0.901
Cardiopulmonary adverse events	8 (1.4%)	2 (1.8%)	5 (2.2%)	1 (0.4%)	0.262
Others	10 (1.8%)	2 (1.8%)	4 (1.8%)	4 (1.8%)	1.000
Death	2 (0.4%)	1 (0.9%)	0 (0)	1 (0.4%)	0.679
Total	73 (12.9%)	14 (12.4%)	29 (12.8%)	30 (13.3%)	0.973

Notes: Others: two cases of sepsis in the longevous group; three cases of sepsis and one case of hepatic encephalopathy in the old-old group; four cases of sepsis in the young-old group. Death: one patient death in each of the longevous and young-old groups from multiple organs failure due to primary disease.

Abbreviation: ERCP, endoscopic retrograde cholangiopancreatography.

Risk Factor Analysis

This study showed that PEP was the most common post-ERCP adverse event in elderly patients. Patient-related factors and procedure-related factors were included in the univariate analysis, which showed that PEP was associated with endoscopic metal biliary endoprothesis (EMBE) and pancreatic duct opacification ($P<0.05$). Multivariate logistic regression analysis showed that EMBE (OR=2.351, 95% CI 1.144–4.832, $P=0.020$) and pancreatic duct imaging (OR=5.774, 95% CI 1.062–31.383, $P=0.042$) were independent risk factors for PEP in elderly patients (Table 5).

Table 5 Univariate and Multivariate Logistic Regression Analysis of Risk Factors for Post-ERCP Pancreatitis in Elderly Patients

Risk factors	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Patient-related risk factors				
Female	1.714 (0.890–3.302)	0.107		
Age	0.990 (0.959–1.022)	0.544		
Periampullary diverticulum	0.882 (0.463–1.679)	0.702		
Choledocholithiasis	0.660 (0.339–1.288)	0.223		
Gallbladder stone	1.267 (0.663–2.420)	0.474		
Biliary stricture	1.723 (0.873–3.401)	0.117		
History of pancreatitis	1.402 (0.315–6.243)	0.658		
Cholecystectomy	0.782 (0.337–1.815)	0.567		
Digestive tract reconstruction	0.683 (0.089–5.236)	0.714		
Procedure-related risk factors				
Incomplete CBD stones removal	0.592 (0.205–1.707)	0.332		
Bougienage	2.711 (0.573–12.816)	0.208		
Pre-cut	1.712 (0.574–5.107)	0.335		
EST	1.430 (0.665–3.074)	0.360		
EPBD	0.540 (0.234–1.248)	0.150		
ENBD	1.334 (0.678–2.624)	0.404		
ERBD	1.244 (0.653–2.368)	0.506		
EMBE	2.315 (1.131–4.738)	0.022*	2.351 (1.144–4.832)	0.020*
ERPD	0.479 (0.112–2.042)	0.320		
Pancreatic duct opacification	5.474 (1.028–29.152)	0.046*	5.774 (1.062–31.383)	0.042*
Guidewire entry into pancreatic duct >1	1.387 (0.403–4.767)	0.604		

Note: * $P<0.05$.

Abbreviations: ERCP, endoscopic retrograde cholangiopancreatography; CBD, common bile duct; EST, endoscopic sphincterotomy; EPBD, endoscopic papillary balloon dilatation; ENBD, endoscopic nasobiliary drainage; ERBD, endoscopic retrograde biliary drainage; EMBE, endoscopic metal biliary endoprothesis; ERPD, endoscopic retrograde pancreatic drainage; OR, odds ratio; CI, confidence interval.

Discussion

With a rise in life expectancy, the number of hospitalized elderly patients with pancreaticobiliary diseases is gradually increasing, and they often develop secondary complications such as acute cholangitis, acute pancreatitis, and obstructive jaundice. Due to the decline in physiological functions and multiple comorbidities, the condition of elderly patients tends to deteriorate rapidly and even requires urgent intervention. On the other hand, elderly patients are usually in a state of immune senescence, critically ill, or intolerance.[6] As a result, compared with younger patients, elderly patients seem to have a higher risk of complication and mortality, and these patients may be reluctant or intolerant to surgery. Compared with surgery, ERCP has the advantages of less trauma, shorter operation time, faster postoperative recovery, and relatively lower cost.[8] Therefore, ERCP might be more suitable for elderly patients.

With the increase of age, the incidence of cholelithiasis and pancreaticobiliary malignancies, changes in the anatomical structure such as PAD and gastrointestinal reconstruction, duodenal stenosis or obstruction, and stone entrapment in papilla increases, which may reduce the cannulation success rate of ERCP and limit its application to some extent.[6,16,17] Although studies have shown that old age is not significantly associated with the incidence of ERCP-related adverse events,[9,10] the above studies only involved elderly patients under the age of 90 years old. The efficacy and safety of ERCP for longevous patients (aged ≥90 years) have not been fully elucidated. In this study, by comparing the endoscopic and clinical data of the longevous, the old-old, and the young-old patients, it was demonstrated that the technical success rate of ERCP in the longevous was 95.6% (108/113), and the overall incidence of adverse events was 12.4% (14/113). There was no significant difference in the technical success rate, incidence of adverse events, and mortality of ERCP among the three elderly patient groups.

Regarding baseline data, in this study, the pre-ERCP clinical manifestations in the three elderly groups were mainly abdominal pain and distension, followed by jaundice, nausea, vomiting, and fever, which may be related to the high incidence of cholelithiasis and biliary obstruction among the elderly patients. Previous studies have shown that CBD stones and obstructive jaundice are the most common indications of ERCP in elderly patients.[18,19] The most common ERCP indication in three groups of patients in our study was choledocholithiasis, which was consistent with previous studies. Nearly half of the patients in the longevous group had acute cholangitis, and the incidence was significantly higher than that of the old-old and young-old groups. It might be due to the declined immune function and poorer nutritional status of longevous patients, who are more susceptible to biliary infections. On the other hand, the longevous often have weaker pain sensitivity and atypical clinical manifestations, which may lead to delayed medical treatment and thus aggravate biliary infections. Our study also showed a high prevalence of comorbid underlying diseases in elderly patients. There was no significant difference in the incidence of the vast majority of comorbidities among the three elderly groups. It is worth mentioning that the incidence of AF in longevous patients was significantly higher than that in young-old patients, which may be associated with vascular aging and degeneration of the myocardium and cardiac conduction system in longevous patients.[20]

Regarding ERCP-related procedures, in this study, choledocholithiasis was the most common intraoperative diagnosis in the three elderly groups, with the highest number of patients with CBD stones diameter ≥1 cm in the longevous group (74.7%). Interestingly, a high detection rate of PAD during ERCP was found in three groups of elderly patients (>50%), although there was no significant difference among the three groups. Studies have shown that PAD is a high-risk factor for the formation of CBD stones.[21] All the elderly patients included in this study underwent ERCP for the first time, and the longevous may be subjected to a longer period of PAD compression in the lower segment of the CBD due to their advanced age, leading to a larger diameter of CBD stones. It has been reported that the complete stone clearance rate of elderly patients (81–94%) is lower than that of young elderly patients (94.9–99.5%).[22,23] In our study, the rate of complete stone clearance in one session of the three elderly patient groups was relatively low (78.6%, 315/401), which may be related to the high proportion of large stones (46–74.7%) and multiple stones (49–63.2%) in this study. Moreover, there was no significant difference in the rate of complete removal of stones at one session among the three groups in this study, which is also different from the above studies. The possible reason is that there was a significant difference in the sample size between elderly and younger elderly patients in the above studies, which might lead to bias in statistical analysis. In contrast, our study reduced the bias of inter-group comparisons through propensity score matching, which might obtain more objective results.

Several studies have shown that EST combined with EPBD and various lithotripsy techniques can be used to assist in the removal of difficult stones, with a higher success rate of stone extraction and a lower risk of complications compared to EST alone.[24,25] In our study, the frequency of mechanical lithotripsy and EPBD procedures was significantly higher in the longevous than in the old-old and young-old groups. The reason might be that the longevous group had more patients with large stones, which resulted in a high frequency of mechanical lithotripsy and EPBD, and similar results were reported by Katsinelos et al.[26] On the other hand, the lower frequency of ENBD in the longevous group in this study could be related to the poorer tolerance of nasobiliary tubes in longevous patients. The main liver function indicators (including aminotransferases and bilirubin) of the three elderly patient groups after ERCP improved significantly compared with that before ERCP, while there was no significant difference in liver function indicators among the three groups both before or after ERCP, which suggested that ERCP was similarly effective for longevous patients compared to other elderly populations.

ERCP-related adverse events mainly include acute pancreatitis, bleeding, perforation, and biliary infection. Previous studies have shown that the overall rate of ERCP-related adverse events in the general population was 5%-10%, and there was no significant difference between younger and older patients in the ERCP-related adverse events, suggesting that advanced age and comorbidities did not lead to more complications.[27,28] However, the above studies mainly involved patients under 90 years of age, and there were rare reports on the safety of ERCP in longevous patients aged 90 years and above. Our study showed that the overall rate of adverse events after ERCP in elderly patients was 12.9%, of which 12.4% in longevous patients, 12.8% in old-old patients and 13.3% in young-old patients during the same period. There was no significant difference in the incidence of adverse events and mortality among the three groups of elderly patients,

indicating that advanced age did not increase the risk of post-ERCP adverse events. It is worth mentioning that only one longevous and one young-old patient died during hospitalization (0.4%), while the cause of death was multiple organs failure due to primary morbidity rather than ERCP itself, which was similar to the findings of Hui et al.[29]

PEP is the most common adverse event after ERCP, and ESGE Guidelines indicate that the incidence of PEP is 3.5–9.7%, with a mortality rate of 0.1–0.7% and can be as high as 14.7% in high-risk populations.[14] In this study, PEP was also the most common post-ERCP adverse event in elderly patients, with an overall incidence rate of 7.1%, similar to the incidence rate of PEP in the general population. Among the elderly patients, the incidence rate of PEP was 5.3% in longevous patients, 7.5% in old-old patients, and 7.5% in young-old patients. There was no significant difference in the incidence rate of PEP among the three groups. Most of the elderly patients in this study had mild pancreatitis, and there were no PEP-related deaths.

This study showed that PEP was the most common post-ERCP adverse event in elderly patients, so it is crucial to explore its risk factors. Various studies showed that females, previous pancreatitis, difficult cannulation, pancreatic guidewire passages >1, and pancreatic injection are definite risk factors for PEP.[8,14,30] However, the risk factors for PEP in elderly patients are unclear. In this study, patient-related factors and ERCP procedure-related factors were included in the logistic regression analysis, and the results showed that EMBE and pancreatic duct opacification were independent risk factors for PEP in elderly patients. The reason might be that EMBE may cause certain mechanical compression of the pancreatic duct, especially in the absence of EST, which increases the risk of PEP. In addition, improper intraoperative procedures and excessive contrast agent injection might lead to pancreatic duct injury or obstruction of pancreatic fluid outflow and increased intra-pancreatic duct pressure, thus increasing the risk of PEP.

Cardiopulmonary adverse events are generally not considered the common adverse events of ERCP. However, advanced-age patients may have an increased risk of cardiopulmonary adverse events during ERCP due to more underlying cardiopulmonary diseases.[12,31] In this study, the incidence of AF was higher in longevous patients than in the other two elderly groups. However, there was no significant difference in the incidence of cardiopulmonary adverse events among the three elderly groups, and no deaths related to cardiopulmonary adverse events occurred. It suggested that advanced age did not increase the incidence of post-ERCP cardiopulmonary adverse events in elderly patients, which is consistent with the results of Zhang et al.[32]

Previous studies on ERCP performed in elderly patients compared elderly patients between the ages of 60–90 years with younger patients, and the sample size of longevous patients (≥90 years) is relatively small.[7,9,13] In this study, we collected clinical data from a total of 113 longevous patients in our hospital in the past almost 15 years, with a longer time span and larger sample size. In addition, old-old and young-old patients were matched as control groups by propensity score to reduce the influence of confounding factors, and the influence of age stratification was also analyzed. The clinical impact of age-stratified results might help clinicians recognize the specific risks of ERCP for elderly patients, especially the longevous population. At last, we analyzed the risk factors for PEP in elderly patients, which was a more in-depth study of post-ERCP adverse events in elderly patients. These findings might provide an important reference for clinical decision-making of ERCP in the longevous population.

However, this study has several limitations. It was a single-center retrospective study; selection bias inevitably occurred, although the influence of confounding factors was minimized by matching the control group. In the future, more prospective, multicenter, and large-sample studies are needed to make a more rigorous conclusion.

Conclusion

By comparing the clinical and endoscopic data of different elderly subgroups, we found that ERCP is generally effective and safe for longevous patients compared with other elderly patients. Although our study revealed that longevous patients had a higher incidence of acute cholangitis and AF than the other elderly patients, advanced age did not increase the incidence of post-ERCP adverse events, suggesting that age should not be considered an contraindication for ERCP. PEP was the most common post-ERCP adverse event in elderly patients, and multivariate logistic regression analysis showed that EMBE and pancreatic duct opacification were the independent risk factors for PEP in elderly patients.

Clinical decision-making should be primarily based on patients' specific conditions and overall health status. These findings in our study might provide an important basis for the individualized assessment and the guidance of clinical decision-making in the longevous population.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethical Statement

This study was approved by the Medical Research Ethics Committee of the First Affiliated Hospital of Nanchang University (No.2024096), which also waived the informed consent due to the retrospective nature of the study. All patient data in our study were anonymized or maintained with confidentiality to protect patient privacy.

Acknowledgments

We thank Zhengping Yu and Ronglai Cao for their kind support and help with data acquisition during the study.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This study was sponsored by Jiangxi Provincial Health Technology Project (202510226), the Project of Jiangxi Provincial Administration of Traditional Chinese Medicine (2023A0021), Clinical Research Cultivation Project of the First Affiliated Hospital of Nanchang University (YFYLCYJPY202425), the National Natural Science Foundation of China (82160694), the Key Laboratory Project of Digestive Diseases in Jiangxi Province (2024SSY06101) and Jiangxi Clinical Research Center for Gastroenterology (20223BCG74011).

Disclosure

The authors declare no competing interests in this work.

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