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Prospective analysis of outcomes in umbilical hernia repair for patients with decompensated cirrhosis

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Abstract

Background Elective umbilical hernia repair (UHR) is recommended for symptomatic patients who have decompensated cirrhosis with ascites. However, the exact timing, the type of surgery, and the factors affecting the outcomes are not clearly defined.

Methods We prospectively collected data of patients with decompensated cirrhosis and ascites, who underwent UHR between January 2016 and July 2024. Complications and mortality were recorded during the early post-surgery period, at 30 days, at 3 months, and at 12 months after surgery. Our aim was to assess the short-term and long-term outcomes of decompensated cirrhotic patients who underwent either elective or emergency UHR.

Results We included 19 patients (15 male), median model for end-stage liver disease score 15 (interquartile range [IQR] 11-39), who underwent UHR (16 emergent, 3 elective). Median survival time at 12 months after UHR was 5.5 months (IQR 0.3-86), whereas the mortality rates at 12 months were up to 68.42% (13/19 patients). No association was found between survival and type of surgery, type of anesthesia, preoperative use of diuretics, ascites grade or laboratory findings. Survival rates at 30 days (P=0.086), 3 months (P=0.022), and 12 months (P=0.031) postoperatively were better in patients who underwent emergent UHR.

Conclusions UHR in decompensated cirrhotics is associated with high mortality. Several risk factors are implicated in the outcomes, with the severity of liver disease having a central role.

Keywords Umbilical hernia repair, cirrhosis, mortality, survival, risk factors

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Introduction

It has been estimated that more than 10% of cirrhotic patients will require surgery other than liver transplantation or hepatocellular carcinoma resection, on either an emergent or an elective basis [1]. Several factors, such as the severity of liver disease, the type and the urgency of surgery, and the risks of general anesthesia, are critical determinants of the outcomes [1]. Even in cases of elective surgery, such as cholecystectomy, colectomy, coronary artery bypass grafting and abdominal aortic aneurysm, mortality rates have been found to be up to 3.4-8 times greater in patients with compensated cirrhosis, and up to 22.7 times higher for cirrhotics with portal hypertension [2]. Emergency abdominal surgery in cirrhotic patients has been associated with a 3-month mortality rate up to 30% and a reduction in postoperative survival of more than 50% at 1 year [2].

Umbilical hernias present in about 20% of cirrhotic patients, rising to 40% in those with ascites [3,4]. Malnutrition, severity of liver dysfunction, previous hernia repair and emergency

procedures (e.g., strangulation, incarceration, evisceration of bowel, perforation, leakage, soft tissue ulceration) are strongly related to complications and higher mortality rates [1,5-7]. When considering elective repair, effective control of ascites and nutrition improvement are proposed as key factors for a better outcome. In selected cases with portal hypertension and uncontrolled ascites, preoperative transjugular intrahepatic portosystemic shunt (TIPS) placement has been proposed as a bridging strategy [8].

A few decades ago, patients were discouraged from proceeding even to an elective herniorrhaphy, in order to avoid post-surgical complications. However, recent studies suggest that elective umbilical hernia repair (UHR) is preferable to conservative management, as the latter is associated with unexpected complications—mainly a decompensated state—and a greater likelihood of severe adverse outcomes, including death [9-14].

Nevertheless, robust scientific data are lacking to establish clear recommendations regarding the exact timing and patient profile for choosing early elective UHR over a "wait and watch" approach. The aim of this study was to assess prospectively the short-term and long-term outcomes of decompensated cirrhotic patients with ascites who underwent either elective (for symptomatic patients) or emergency UHR, and to identify the risk factors associated with these outcomes.

Patients and methods

Study population

Consecutive patients with decompensated cirrhosis of any etiology and umbilical hernia requiring surgical treatment, regularly followed at the University Hospital of Heraklion, Greece, between January 2016 and July 2024, were included in the study. Exclusion criteria were: age under 18 years, history of liver transplant; severe cardiorespiratory diseases; including recent major cardiac comorbidities (recent myocardial infarction; major valvular failure; cardiac failure more advanced than NYHA II); and major respiratory disease (such as severe chronic obstructive pulmonary disease, advanced fibrosis). The ascites diagnosis was based on clinical and ultrasonographic findings. Preoperative and postoperative management of patients presenting with ascites was tailored to its severity. For patients with grade I and II ascites, diuretics were administered. In cases of grade III or refractory ascites, management consisted of paracentesis combined with human albumin substitution, as appropriate. All patients received antibiotics both preoperatively and postoperatively. Coagulopathy was addressed using intravenous vitamin K, and in cases of severe thrombocytopenia platelet transfusion. Other clotting agents were used rarely, according to clinical requirements.

Umbilical hernia was diagnosed through clinical examination. Emergency procedures were defined as those performed within 12 h after a diagnosis of a complication, such as strangulation, incarceration or perforation. The choice of surgical technique—whether sutures only, or with the application of a mesh—was at the discretion of the treating surgeon. When feasible, local anesthesia was preferred over general anesthesia.

Following hospital discharge, patients were followed-up in the outpatient clinic. Complications and mortality were recorded at multiple time points: during postoperative hospital stay, at 30 days, at 3 months and at 12 months after surgery. Hernia recurrence at follow up was assessed through clinical examination at each follow-up visit. The cause of death for each patient was recorded and was classified as postoperative if it occurred within 30 days after hernia repair, or as related to liver disease if it occurred thereafter.

Demographics including sex, age, smoking history, other comorbidities, including diabetes mellitus, hepatocellular carcinoma and portal vein thrombosis, and use of diuretics were also recorded.

Clinical and laboratory data were collected prospectively at study enrollment, at the time of surgery and at the end of the study. Laboratory evaluations included full blood count, international normalized ratio (INR), serum creatinine (Cr), total bilirubin and albumin levels.

The severity of liver disease was documented using the Child-Turcotte-Pugh (CTP) and model for end-stage liver disease (MELD) scores. These scores were also documented at enrollment, at surgery and at the end of the study for each patient [15,16]. The study protocol was approved by the institutional review board of the University Hospital of Heraklion.

Statistical analysis

Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as median values and interquartile range (IQR) or mean ± standard deviation. Comparisons between groups were performed using the Pearson chi-square test for categorical variables and Student's *t*-test or Mann-Whitney *U* test for continuous variables. A P value <0.05 was considered statistically significant. Survival analysis was conducted using the Kaplan-Meier method to evaluate transplant-free survival according to type of umbilical hernia surgery, type of anesthesia, preoperative grade of ascites, preoperative use of diuretics, smoking history, preoperative MELD score and preoperative laboratory parameters (e.g., serum albumin, platelet count, serum Cr, serum total bilirubin or INR). Differences between groups were assessed by log-rank test. Statistical analyses were conducted using the SPSS software package (version 29 for Windows; SPSS Inc., Chicago, IL, USA).

Results

Nineteen patients (15 male) with decompensated cirrhosis, who underwent emergency or elective UHR, were included in the study. The median preoperative MELD score was 15 (range: 11-39). The etiology of cirrhosis was identified as alcoholic

liver disease (ALD) in 10 patients (52.63%), chronic hepatitis (HBV or HCV) in 5 patients (26.31%), 2 of whom also had concurrent ALD, autoimmune hepatitis in 2 patients (10.53%), and metabolic dysfunction-associated steatotic liver disease in 2 patients (10.53%). Among the patients with HCV etiology, 3 had had sustained virological response under direct-acting antiviral treatment, whereas one was too sick and was assigned to be treated with liver transplantation, but unfortunately, he did not have the opportunity. The patient with HBV continued entecavir treatment and HBV DNA was undetected. Of the 10 patients with alcoholic etiology, 5 patients (26%) were abstinent for at least 6 months whereas the rest did not abstain.

At inclusion, the majority of patients had significant ascites grade II or III, except for 2 patients who had grade I ascites. Thirteen patients (68.42%) were receiving diuretics, while 4 had hepatorenal syndrome type II preoperatively. Comorbidities and patients' characteristics are summarized in Table 1.

UHR was performed electively in 3 of 19 (15.79%) symptomatic cirrhotic patients. The indications for emergency surgery were umbilical hernia strangulation in 9 patients, perforation in 6 patients and incarceration in 1 patient. There was no statistically significant difference in preoperative laboratory findings, including INR, bilirubin, albumin, Cr and MELD score, between patients with emergent and elective UHR (Table 2).

Table 1 Preoperative characteristics of study participants

Characteristics	Patients with liver cirrhosis
Male sex, N=19 (%)	15 (78.95%)
Median age (years), IQR	59 (41-77)
CTP score class B, N=19 (%)	13 (68.42%)
CTP score class C, N=19 (%)	6 (31.58%)
MELD score, median (IQR), N=19	15 (11-39)
HRS, N=18*	4 (22.22%)
Smoking, N=19 (%)	10 (52.63%)
Comorbidities, N=19 (%)	
DM	3 (16.67%)
HCC	4 (21.05%)
PVT (n=16)	4 (21.05%)

* We included 18 patients in the analysis for HRS because we did not have full data for 1 female patient who died at home

IQR, interquartile range; MELD, model for end-stage liver disease; HRS, hepatorenal syndrome; DM, diabetes mellitus; HCC, hepatocellular carcinoma; PVT, portal vein thrombosis; CTP, Child-Turcotte-Pugh

Hernioplasty was performed in 8 out of 19 patients (4 with and 4 without mesh). Patients with hernioplasty had higher mean bilirubin values, Cr and MELD score, and lower mean albumin and INR compared to patients undergoing herniorrhaphy, although the differences were not statistically significant (Table 2).

A simpler technique with herniorrhaphy was performed in 11 of 19 cirrhotic patients, all with ascites grade III, 3 with CTP class C and 8 with CTP class B. Nine of 19 patients (47.37%) were operated under local anesthesia, 7 of 9 had herniorrhaphy, even though in 5 the indication was perforation of the umbilical hernia.

Mortality and survival rates

Five patients (26.32%) died within 30 days after surgery, and 4 more died within 3 months after surgery. No deaths occurred either immediately post-surgery or within 7 days. Overall, 13 patients (68.42%) died within 12 months after surgery, with 2 additional deaths occurring at 14 months and 19 months post-surgery. The 30-day mortality causes included multiple organ failure (MOF) in 3 patients, hepatorenal syndrome, and liver failure in 1 patient, and an unknown cause in a female patient who died at home. All these patients were classified as CTP class C. At 3 months postoperatively 4 additional patients had died (3 from gastrointestinal or variceal bleeding and 1 from MOF). The overall mortality at 12 months (13/19, 68.42%) was attributed to the following causes: 5/13 MOF, 3/13 with HRS and liver failure, 3/13 with gastrointestinal/variceal bleeding, 1/13 with pneumonia and liver failure, and 1/13 of unknown etiology.

By the end of the study period, only 4 patients were alive. Among them a 49-year- old male patient with ALD and HCV-related cirrhosis CTP class C, underwent liver transplantation at 23 months after UHR, with a follow up of 86 months after surgery. No patient had umbilical hernia recurrence or any immediate major surgical complication. Laboratory tests at study entry, pre- and post-UHR surgery are shown in Table 3.

The median survival time from surgery to the end of the study was 5.5 months (IQR 0.3-86). Among the 9 patients who underwent UHR under local anesthesia, 2 (22.2%) were alive at the end of the study period, compared with 2/10 (20%) who underwent surgery under general anesthesia. The type of anesthesia (local vs. general) had no significant association with 30-day, 90-day, 12-month and overall survival (P=0.888) in cirrhotic patients who underwent UHR surgery (Table 4, Fig. 1). Likewise, there was no difference in survival between

Table 2 Differences in mean laboratory results preoperatively, between emergent or elective UHR and hernioplasty or herniorrhaphy in our cirrhotic cohort

Lab results	Emergent UHR*	Elective UHR	P-value	Hernioplasty	Herniorrhaphy	P-value
INR[$]	1.75±0.96	1.5±0.2	0.66	1.57±0.26	1.81±1.16	0.584
Total bilirubin	2.99±1.84	1.17±0.63	0.114	3.09±1.26	2.42±2.16	0.439
Serum albumin	4.65±6.98	3.43±0.35	0.736	3.24±0.47	5.64±8.42	0.436
Creatinine	1.28±0.72	1.91±1.24	0.234	1.42±0.91	1.36±0.78	0.884
MELD[#] score	18.062±7.21	17±6.08	0.814	18.37±5.01	17.54±8.22	0.804

All values are expressed as mean ± SD

**UHR, umbilical hernia repair; INR, international normalized ratio; MELD, model for end-stage liver disease*

Table 3 Laboratory findings pre- and postoperatively

Lab findings	Pre-umbilical hernia repair	At surgery	Postoperative follow up
Creatinine (mg/dL)	1.4±0.6	1.38±0.81	1.82±1.41
Total bilirubin (mg/dL)	2.71±1.81	2.71±1.83	8.48±11.27
Albumin (g/dL)	3.14±0.52	3.16±0.41	2.97±0.66
INR	1.75±0.92	1.71±0.88	2.61±2.87
PLT ($\times 10^9$/L)	113.13±70.63	109.05±51.70	87.99±67.02
CTP score class A	0	0	2
CTP score class B	9 (N=14)	13	4
CTP score class C	5 (N=14)	6	11
MELD score (median, IQR)	17 (13-39) (n=16)	15 (11-39)	21 (8-42) (n=18)

All values are expressed as mean ± standard deviation, unless otherwise indicated

INR, international normalized ratio; PLT, platelets; CTP, Child-Turcotte-Pugh; MELD, model for end-stage liver disease; IQR, interquartile range

cirrhotic patients who underwent hernioplasty compared to herniorrhaphy, at any of the above time points (Table 4) (Fig. 2). At the end of the study, 25% of patients who had undergone hernia repair, with or without mesh, were alive, compared to 18.2% of those who had herniorrhaphy (P=0.687). No statistically significant association was found between survival at 30 days, 3 months and 12 months, and the grade of ascites (grade III vs. grade I, II), use of diuretics smoking history or preoperative MELD score (Table 4). No direct association was found between mortality and UHR operation.

None of the preoperative laboratory parameters, such as low serum albumin levels, low platelets, elevated Cr, hyperbilirubinemia or prolonged INR, were significantly associated with survival rates in the cohort (Table 4).

Among patients undergoing emergency UHR, 13 of 16 patients were alive at 30 days postoperatively, compared to 1 of 3 patients undergoing elective surgery (81.25% vs. 33.3%, P=0.086). Survival rates were significantly higher in patients with emergent umbilical hernia (10/16) repair, compared to elective surgery (0/3), at 3 months (62.5% vs. 0%, P=0.022) and at 12 months (31.25% vs. 0%, P=0.031).

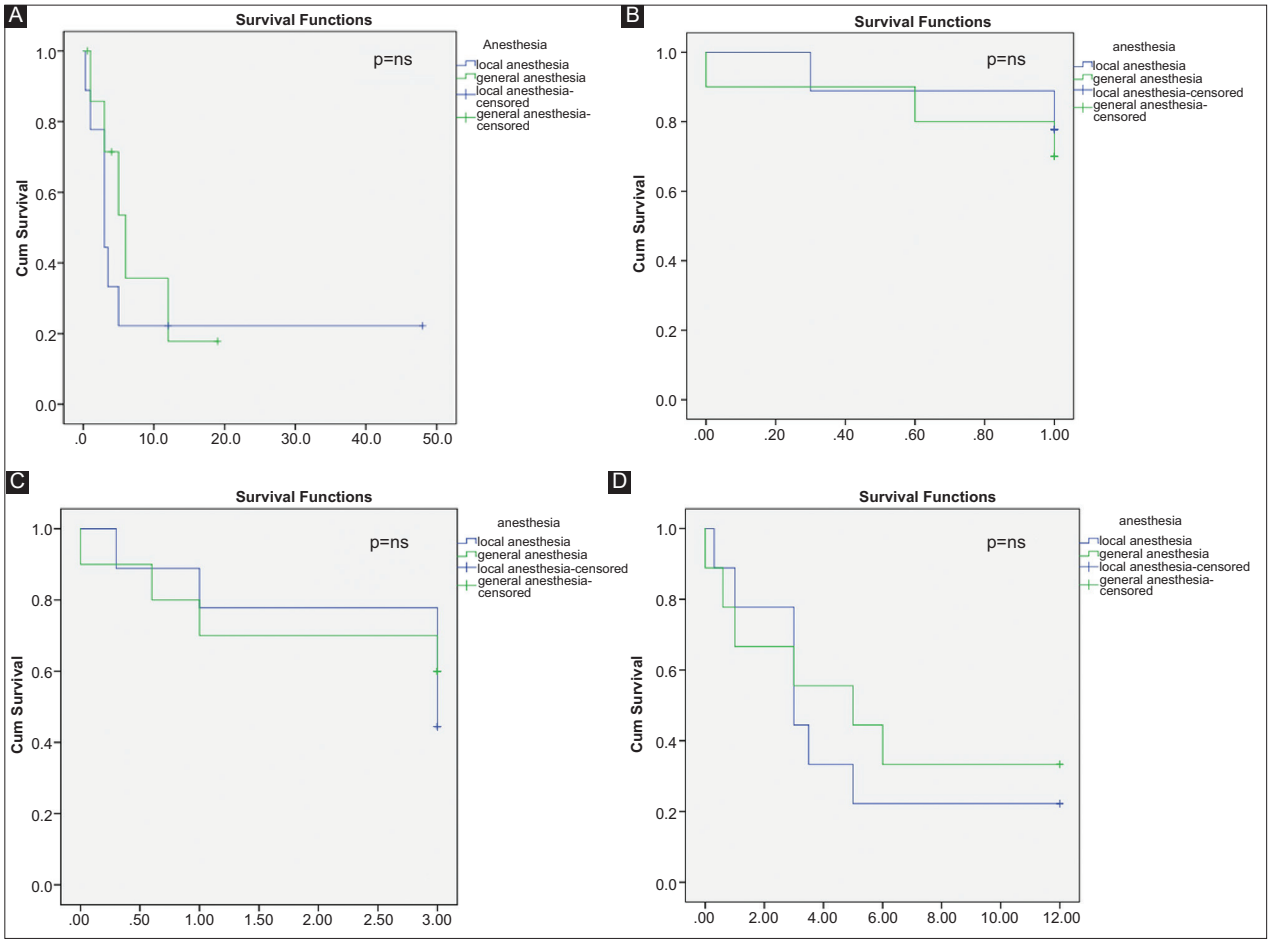

Figure 1 Survival after umbilical hernia repair in cirrhotic patients by preoperative type of anesthesia. (A) Overall survival, (B) 30-day survival, (C) 3-month survival, (D) 12-month survival

Table 4 Survival rates of 19 patients with decompensated cirrhosis based on parameters related to surgery, clinical and laboratory findings preoperatively

Parameter	30-day survival, %	P-value	90-day survival, %	P-value	12-month survival, %	P-value
Local anesthesia	77.8%	0.687	44.4%	0.693	22.2%	0.688
General anesthesia	70%		60%		33.3%	
Hernioplasty	75%	0.76	50%	0.971	28.6%	0.86
Herniorrhaphy	72.7%		54.5%		27.3%	
Emergent surgery	81.25%	0.086	62.5%	0.022	31.25%	0.031
Elective surgery	33.3%		0%		0%	
Smokers	80%	0.502	50%	0.987	20%	0.731
Non-smokers	66.7%		55.6%		37.5%	
Use of diuretics	76.9%	0.813	61.5%	0.401	33.3%	0.511
No use of diuretics	66.7%		33.3%		16.7%	
Ascites grade III	78.6%	0.76	57.1%	0.532	28.6%	0.975
Ascites grade I/II	66.7%		33.3%		33.3%	
PLT ($\times 10^3$ /μL)		0.687		0.752		0.467
<100	70%		50%		33.3%	
≥100	77.8%		55.6%		22.2%	
Creatinine (mg/dL)		0.896		0.6		0.416
≥1.5	71.4%		42.9%		14.3%	
<1.5	75%		58.3%		36.4%	
Albumin (g/dL)		0.979		0.82		0.445
>3	72.7%		54.5%		40%	
≤3	75%		50%		12.5%	
Bilirubin (mg/dL)		0.94		0.632		0.997
≥3	71.4%		42.9%		28.6%	
<3	75%		58.3%		27.3%	
INR		0.979		0.62		0.927
≥1.5	72.7%		45.5%		27.3%	
<1.5	75%		62.5%		28.6%	
MELD score		0.687		0.752		0.467
>15	77.8%		55.6%		33.3%	
≤15	70%		50%		22.2%	

PLT, platelets; INR, international normalized ratio; MELD, model for end-stage liver disease; IQR, interquartile range

Cox regression multivariate analysis was not performed, as the small sample size would probably have led to results with insufficient statistical power.

Discussion

In patients with decompensated cirrhosis, UHR is a complex clinical challenge. The timing, the type of surgery and the risk stratification of patients with end-stage liver disease and ascites remains controversial. Recent guidelines from European and American societies recommend an earlier elective surgical repair after optimal management of ascites, particularly for patients with MELD score <15 and serum albumin >3 g/dL [17].

In our study involving decompensated cirrhotic patients who underwent UHR, either electively or urgently, we observed low survival rates (36.84%) at 12 months, with worse outcomes in the elective UHR group**.** Statistically significantly lower survival rates were found in patients undergoing elective repair.

In our cohort, the median survival time from surgery to the end of the study was only 5.5 months, reflecting the severity of liver disease (none of the patients were classified CTP class A). The high percentage of patients with emergent UHR (84.21%) further influenced our analysis, as there was a large imbalance between the 2 study groups.

A recent systematic review comparing outcomes for UHR between cirrhotic and non-cirrhotic patients reported a 6% mortality rate and 8.5 times greater risk for lethal complication in cirrhotic patients. Notably, emergent UHR was associated with an almost threefold greater 90-day mortality risk in patients with cirrhosis [18]. In the randomized CRUCIAL study, mortality at 24 months was lower for patients undergoing elective surgical intervention compared to a wait-and-see approach (12.5% vs. 44.4%) [14]. Our study demonstrated high overall mortality rates

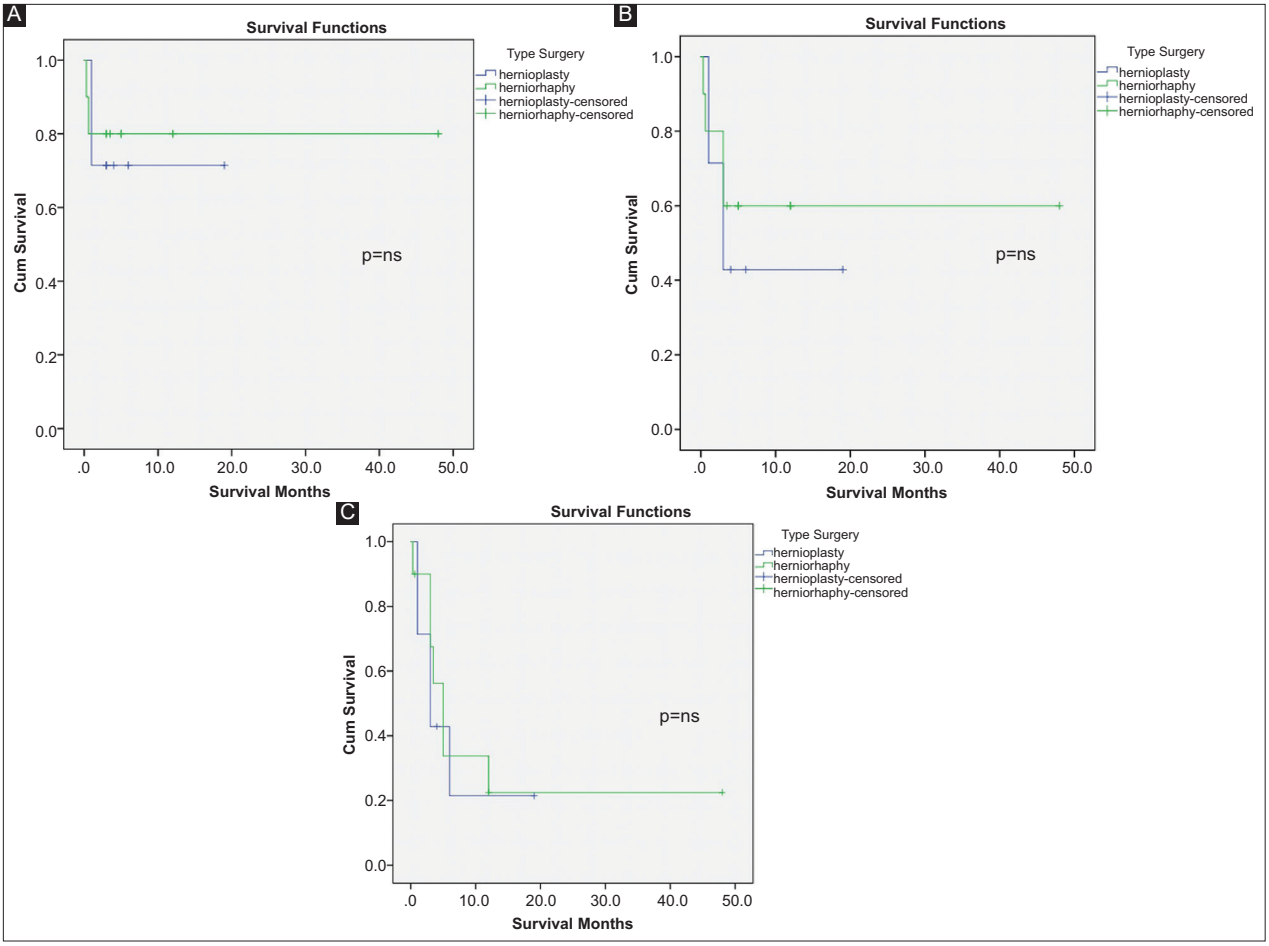

Figure 2 Survival curves depending on surgical technique used for umbilical hernia repair among patients with decompensated cirrhosis. (A) 30 days after surgery, (B) 3 months after surgery, (C) 12 months after surgery

of 26.32% at 30 days and 68.42% at 12 months post UHR. Similar findings have been previously reported in other retrospective studies, with 30-day mortality rates up to 19.6% and 12-month rates reaching 50% (Table 5) [19-22].

There are conflicting data regarding the survival benefits of early elective surgery for umbilical hernia in cirrhotics (Table 5). In the Netherlands, in a prospective study of 30 patients who underwent elective UHR with mesh, the 25-month mortality rate was only 7% (2/30), unrelated to postoperative complications [23]. This cohort had a lower median baseline MELD score (12, IQR 8-16) than ours (15, IQR 11-39), and up to 20% of patients were CTP class A. A more recent large retrospective study from the USA, using ICD-10 codes, found that elective UHR in cirrhosis was independently associated with a 64% reduction in mortality compared to emergency surgery [21]. Moreover, patients with compensated cirrhosis had similar survival rates to non-cirrhotic patients, indicating that the degree of liver disease plays the most important role in patient selection for either an elective or an emergency UHR.

Emergency repair of any type of abdominal wall hernia in patients with advanced stages of cirrhosis has been associated with high rates of perioperative complications, prolonged hospital and intensive care unit stay, and higher mortality [19,24,25]. However, in the prospective study by Hew *et al* no difference in 90-day mortality rates (1.3% vs. 0%, P=0.43) was found among 79 cirrhotic and 249 non-cirrhotic patients with emergent UHR, though cirrhotics experienced a higher complication rate (62% vs. 20%, P=0.01) [26]. In our patient cohort, short-term and long-term mortality rates were high for both elective and emergency UHR, correlating with the severity of liver disease. Notably, there were no immediate surgical complications in our patients.

It has been reported that conservative treatment of ruptured umbilical hernia in cirrhotic patients confers a high mortality risk: over 60%, compared to up to 20% related to emergency herniorrhaphy [4,27-29]. As for the preferred surgical approach, umbilical herniorrhaphy (non-mesh) on an elective basis has been recommended in cirrhosis, as it has been associated with fewer postoperative complications, and lower morbidity and mortality rates compared to emergency UHR. Recently, a randomized controlled trial showed that elective herniorrhaphy of the umbilical hernia in cirrhotics does not cause excess morbidity compared to the conservative approach [14]. Thus, it could be a more feasible and safe option than a watchful waiting strategy, especially when performed in earlier stages of liver cirrhosis. In the majority of 21 emergency

Table 5 Studies assessing mortality rates for elective or emergent UHR and risk factors for post UHR morbidity and mortality

Study [ref.]	Study design	Mortality rate	Follow up	Risk factors for post UHR morbidity and mortality
Snitkjær *et al* [18] (CRUCIAL trial)	Randomized controlled trial	12.5% UHR group vs. 44.5% conservative group (24-month)	2-3 weeks, 3 months, 12 months up to 24 months after UHR	- MELD score ≥15, incarceration, skin necrosis, unexpected ICU admission, higher mortality - Equal UHR-related complications for elective vs conservative approach
Eker *et al* [23]	Prospective single-LT center (all elective UHR)	7% in 10 and 25 months	Median follow up of 10 and 25 months (IQR 14-34)	No correlation between MELD or CTP score and post-UHR complications
Andraus *et al* [19]	Retrospective	17.8% emergent UHR vs. 1.8% elective (30-day)	Median 27months (range1-115).	- Emergent UHR (OR 7.31, 95%CI 1.42-37.61; P=0.017) and CTP class C (OR 4.54, 95%CI 1.09-18.84; P=0.037) for post-surgical morbidity - Emergent UHR for mortality (OR 10.83; P=0.028)
Neeff *et al* [20]	Retrospective analysis using ICD-10 codes	19.6%, 30-day mortality 29.9%, 90-day mortality for general and gastrointestinal surgery	Survival was estimated up to 5-years post-surgery (25.4%)	- 30-day mortality: CTP score (AB vs. C), MELD (≤19 vs ≥20), ASA score (1-3 vs. 4+5), emergent operations, intraoperative transfusions, elevated preoperative CR - 90-day mortality: CTP score (AB vs. C), MELD (≤19 vs. >20), ASA score, emergent operation, major operation, low PLT, low serum sodium
Hill *et al* [21]	Retrospective review of a national inpatient database	Higher mortality for all groups in the emergent group 3% for NC,7% for CC and 8% DC. Higher mortality for CC vs. NC and DC vs. NC (P<0.001 and P<0.0001, respectively).	Length of impatient stay up to 16 days	Elective repair was independently protective (a 64% reduction in mortality risk)
Alsina *et al* [22]	Retrospective Case-control	- 11.7% UHR group (6-month), overall 6.6% at 6 months - 8.8% for CTP class B - 10.7% for CTP class C for all procedures - 20% in the cirrhotic group for all procedures	6 months	N/A
Adiamah *et al* [24]	Retrospective case-control using electronic healthcare databases (England)	19% in the cirrhotic group for emergent UHR vs. 2% in the elective setting	90-day	- Patients with cirrhosis / elective UHR had increased ×12 odds of mortality (OR 12.14, 95%CI 4.36-33.84) after adjusting for age, sex and comorbidity - DC had ×9 higher odds of mortality at 90 days (OR 9.51, 95%CI 4.97-18.19) compared with NC after adjusting for the same confounders
Shahait *et al* [25]	Retrospective study (emergent vs. elective UHR)	NA	NA	Hypoalbuminemia, emergency repair and MELD score as independent predictors of poor outcomes
Hew *et al* [26]	Retrospective case-control study (single center)	1/79 in the cirrhotic cohort (1.3%) (emergency repair, died 23 days after UHR) 0/249 in the control group (0%) (P=0.26)	90-day	Independent predictors of post-operative complications in cirrhosis: MELD score, emergency repair, repair of a recurrent hernia and preoperative ascitic tap

(*Contd...*)

Table 5 (*Continued*)

Study [ref.]	Study design	Mortality rate	Follow up	Risk factors for post UHR morbidity and mortality
Fagan *et al* [27]	Case report	3 patients with complicated UR and emergency repair followed by TIPS procedure	3-month (case 1) 5-month (case 2) 13-month (case 3)	NA
Telem *et al* [28]	Retrospective	(4/20) 20% all patients, 50% vs. 24% for emergent vs elective	36-month	Spontaneous umbilical rupture independently correlated with adverse outcome (OR 25, 95%CI 1.2-521, P=0.02)
Malik *et al* [30]	Retrospective	4.8% (30-day), 6.8% (90-day), 14.6% (1-year)	30-day up to 1-year	- MELD score >15 predicted 90-day mortality (OR 18.48, 95%CI; P=0.030) - Hyponatremia predicted 1-year mortality (OR 5.31, 95%CI; P=0.047). TIPS predicted survival at 1 year (OR 0.15, 95%CI; P=0.038)
Gray *et al* [11]	Retrospective multicenter (16 VA Medical Centers) case–control study using Current Procedure Terminology (CPT) and ICD-9 codes	One in 127(0.78%) cirrhotic patients (30-day) Five in 1294 (0.39%) non-cirrhotic (30-day)	30-day	- Predictors of complications were emergent UHR, diabetes, congestive heart failure, chronic obstructive pulmonary disease - Cirrhosis (OR 4.4, 95%CI 1.3-14.3) strongly associated with postoperative complications in emergent UHR - Cirrhosis was not a significant predictor of post-UHR complications in total
Choi *et al* [12]	Retrospective	No difference in mortality between elective (6%) vs. emergent UHR (0%) (P=NS)	Early postoperative period	- More complications in the emergent UHR group (22.6% vs. 19.4%, P=0.01) - Mortality associated with liver cirrhosis complications after UHR under general anesthesia

UHR, umbilical hernia repair; MELD, model for end-stage liver disease; ICU, intensive care unit; LT, liver transplantation; IQR, interquartile range; CTP, Child-Turcotte-Pugh; OR, odds ratio; ASA, American Society of Anesthesiologists; CR, creatinine; PLT, platelets; CC, compensated cirrhosis; NC, non-cirrhotic; DC, decompensated cirrhosis; CI, confidence interval; TIPS, transjugular intrahepatic portosystemic shunt NS, nonsignificant

herniorrhaphy cases reported by Telem *et al*, the 20% mortality rate at 36 months was mainly attributed to advanced liver disease. In this retrospective study, management of ascites also included 6 cases of preoperative and 2 cases of postoperative TIPS [28]. In our study, none of our patients had TIPS for the management of ascites, a procedure that has been associated with better outcomes and survival in previous studies [28,30]. Portal decompression with TIPS can be considered in selected high-risk patients, but further prospective studies of this recommendation are required.

Mortality rates at 12 months were similar for both herniorrhaphy and hernioplasty in our cohort. Our finding is in line with other studies where hernioplasty was applied for UHR with favorable outcomes, mainly affected by CPT score, surgeons' skills and experience [22,24,31,32]. Laparoscopic umbilical hernia repair and other novel approaches, such as complex abdominal wall reconstruction with biologic mesh, have been also proposed as effective and probably safer operative options in selected cases [33-35]. In a more recent retrospective study of 1983 patients with liver dysfunction and AST-to-platelet ratio index ≥1 who underwent UHR, 476 patients had a laparoscopic surgical approach. No difference in serious complications and mortality rates was found, but laparoscopy was associated with shorter hospital stays and lower transfusion requirements compared to the open surgical approach [36].

The main limitations of our study are the small sample size, the non-randomized design and the inclusion of a disproportionately high number of emergency UHR cases compared to elective procedures. Consequently, our study lacks sufficient power to accurately detect the clinical and laboratory characteristics of cirrhotic patients with umbilical hernia who would benefit most from an early and elective UHR. Another limitation is that since we did not have the first diagnosis of umbilical hernia in every patient, there was no information about the time between umbilical hernia diagnosis and treatment.

Considering the limited number of studies examining UHR in patients with decompensated cirrhosis and ascites, our study adds to the current body of knowledge on this topic. We confirmed that advanced CTP classes (B and C) are the primary factors driving poor survival in these patients. Opting for UHR, under local anesthesia if possible, and preferably at earlier stages of cirrhosis, is the optimal practice. Further larger and well-designed randomized studies are warranted to guide the operative management of cirrhotic patients with ascites and umbilical hernia.

Summary Box

What is already known:

- Studies examining the type of surgery and the exact timing for umbilical hernia repair (UHR) in decompensated cirrhotic patients with ascites are limited
- Data on risk stratification for UHR in patients with end-stage liver disease and ascites are elusive

What the new findings are:

- We prospectively assessed the short- and long-term outcomes of 19 cirrhotic patients with ascites, who underwent either elective or emergency UHR, and evaluated any possible risk factors associated with these outcomes
- Patients who underwent UHR, either electively or urgently, had high overall mortality rates of 26.32% at 30 days and 68.42% at 12 months, with worse outcomes in the elective UHR group
- We confirmed that advanced Child-Turcotte-Pugh classes B and C are the primary factors driving poor survival in these patients
- Opting for UHR under local anesthesia, preferably at earlier stages of cirrhosis, is the optimal practice

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