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Fates of retained hepatic segment IV and its prognostic impact in adult split liver transplantation using an extended right liver graft

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Purpose: When splitting a liver for adult and pediatric graft recipients, the retained left medial section (S4) will undergo ischemic necrosis and the right trisection graft becomes an extended right liver (ERL) graft. We investigated the fates of the retained S4 and its prognostic impact in adult split liver transplantation (SLT) using an ERL graft.
Methods: This was a retrospective analysis of 25 adult SLT recipients who received split ERL grafts.
Results: The mean model for end-stage liver disease (MELD) score was 27.3 ± 10.9 and graft-recipient weight ratio (GRWR) was 1.98 ± 0.44. The mean donor age was 26.5 ± 7.7 years. The split ERL graft weight was 1,181.5 ± 252.8 g, which resulted in a mean GRWR of 1.98 ± 0.44. Computed tomography of the retained S4 parenchyma revealed small ischemic necrosis in 16 patients (64.0%) and large ischemic necrosis in the remaining 9 patients (36.0%). No S4-associated biliary complications were developed. The mean GRWR was 1.87 ± 0.43 in the 9 patients with large ischemic necrosis and 2.10 ± 0.44 in the 15 cases with small ischemic necrosis (P = 0.283). The retained S4 parenchyma showed gradual atrophy on follow-up imaging studies. The amount of S4 ischemic necrosis was not associated with graft (P = 0.592) or patient (P = 0.243) survival. A MELD score of >30 and pretransplant ventilator support were associated with inferior outcomes.
Conclusion: The amount of S4 ischemic necrosis is not a prognostic factor in adult SLT recipients, probably due to a sufficiently large GRWR.
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Key Words: Deceased donor, Donor shortage, Extended right liver graft, Left medial segment, Whole liver graft

INTRODUCTION

There has been a persistent shortage of deceased donor organs for liver transplantation (LT) and split LT (SLT) was developed to address this issue [1]. According to the European Liver Transplant Registry, the proportion of SLTs was around 6% of all deceased donor LTs (DDLTs) in the 2000s [2,3]. In contrast, however, SLTs comprised less than 1% of all LTs between 2002 and 2009 in the United States [4]. In Korea, there were 2,462 DDLT recipients from 2005 to 2014 and 86 adult patients in this group (3.5%) received a split extended right liver (ERL) graft [5]. It has often been reported that the survival rate of patients undergoing SLT is not significantly different from that of whole liver transplant recipients [6-10]. Conventional SLTs involve dividing the deceased donor liver into a left lateral section (LLS) graft for a pediatric recipient and an ERL graft for an adult

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recipient. Most SLTs to date have been the conventional type, and this has proven to be effective in shortening the waiting list for pediatric LT candidates [8,11].

In conventional liver splitting for adult and pediatric recipients, the usual LLS graft is actually an extended LLS graft. The left medial section (segment IV [S4]) which is retained at the right liver does not function because the inflow vessels and bile duct are transected. As a result, the right trisection graft actually becomes an ERL graft [12,13]. The retained S4 parenchyma often undergoes silent atrophy but retained S4-associated complications such as ischemic parenchymal necrosis and biliary leak can develop. These complications increase morbidity and can sometimes lead to graft loss [9,14,15]. Consequently, some authors have proposed systematic removal of the retained S4 during SLT [16-18]. We previously reported a case of retained S4 resection due to intractable bile leak after donation of an LLS graft in a living donor [13].

In our present study, we investigated the fates of the retained S4 and its prognostic impact in adult patients who underwent SLT using a split ERL graft.

METHODS

Study design

This study was a retrospective analysis of single-institution DDLT data from the Asan Medical Center. The study patients were 25 adults who underwent DDLT using a split ERL graft. The study period for patient selection was set from January 2000 to April 2019, thus making a minimal posttransplant observation period of 1 year. To avoid unnecessary selection bias, only the patients who underwent primary LT were included and any retransplantation cases were excluded. The Institutional Review Board of Asan Medical Center approved this study protocol (IRB No. 2020-0857). The requirement for informed consent was waived due to the retrospective nature of this study.

Donor selection for split liver transplantation

The donor selection criteria for SLT included stable hemodynamics, age of ≤40 years, bodyweight of ≥50 kg, and low-dose use of inotropics [5]. Korean Network for Organ Sharing (KONOS) has a mandatory splitting policy only for a combination of adult and child recipients. If the deceased donor candidate fulfills the criteria for SLT, KONOS selects an appropriate match for adult and child recipient candidates on the waiting list. If no proper matches are available, the whole liver graft from a deceased donor is allocated to an adult recipient candidate.

Operative techniques for liver splitting

The surgical techniques for adult-child SLTs are described in detail elsewhere [19]. Many transplant surgeons in Korea are well accustomed to the *in situ* splitting technique, thus all of our split donor cases underwent *in situ* splitting as done for living donor LT (LDLT). The LLS graft is actually an extended LLS graft and the portal vein and hepatic artery to the S4 are therefore completely transected. The S4 bile ducts are also divided and securely closed to prevent bile leak from the liver cut surface. Procurement of an LLS graft after *in situ* splitting is often performed in advance as in pediatric LDLT cases. Thereafter, the remnant right liver graft was concurrently harvested with other abdominal organs and implanted into the adult recipients like the usual DDLT procedures using a whole liver graft (Fig. 1).

Definition of specific complications

Retained S4-related complications were classified as ischemic parenchymal necrosis and biliary leak. These were evaluated with serial posttransplant liver dynamic CT scans until 1 year after SLT operation. In accordance with our institutional LT management protocols, posttransplant dynamic CT scans were taken weekly when the patients were in the hospital, and then at 1, 3, 6, and 12 months after the LT operation. The amount of ischemic infarct of the S4 parenchyma was classified using 1-week CT volumetry as either large (>10% of the split right liver graft volume) or small (≤10% of the split graft volume). Biliary leak was defined as the presence of overt bile in the abdominal drain.

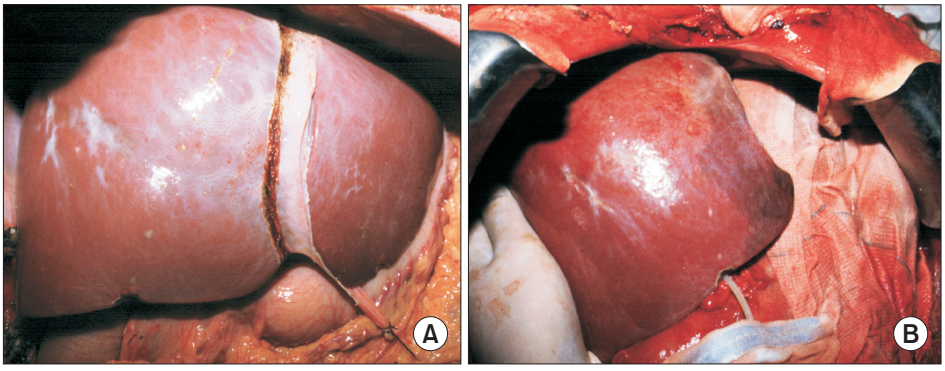

Fig. 1. Intraoperative photographs of the deceased donor and adult recipient. (A) A hepatic transection line was marked along the falciform ligament of the donor liver. (B) The implanted extended right liver graft showed discoloration at the retained segment IV parenchyma (B).

Statistical analysis

Numerical data are presented as a mean ± standard deviation. Continuous variables were compared using the Student t-test. The incidence variables were compared using the chi-square test and Fisher exact test. Survival rates were estimated using the Kaplan-Meier method and compared with the log-rank test. A P-value <0.05 was considered statistically significant. Statistical analyses were performed using IBM SPSS Statistics ver. 22 (IBM Corp., Armonk, NY, USA).

RESULTS

Patient grouping and profiles

After exclusion of retransplantation SLT cases and 2 adult SLT cases, 25 adult patients who underwent primary DDLT with a split ERL graft were selected for our current analyses.

Table 1. Profiles of the 25 adult recipients who underwent split liver transplantation

Parameter	Data
Sex (male:female)	17:8
Age (yr)	50.6 ± 11.2
Primary disease	
HBV-LC	11 (44.0)
HCV-LC	1 (4.0)
Alcoholic liver disease	6 (24.0)
Acute and subacute liver failure	4 (16.0)
Others	3 (12.0)
Preoperative laboratory finding	
Total bilirubin (mg/dL)	21.8 ± 17.5
Serum creatinine (mg/dL)	1.51 ± 1.19
PT (INR)	2.4 ± 1.1
MELD score	27.3 ± 10.9
KONOS MELD score status	
1	3 (12.0)
2	3 (12.0)
3	5 (20.0)
4	8 (32.0)
5	6 (24.0)
Pretransplant ventilator support	6 (24.0)
Pretransplant renal replacement	7 (28.0)
HCC at the explant liver	8 (32.0)
Graft-recipient weight ratio	1.98 ± 0.44
Ischemic time (min)	
Cold	219.1 ± 119.4
Warm	49.8 ± 14.9
Total	268.9 ± 124.0
Retransplantation within 6 months	1 (4.0)

Values are presented as number only, mean ± standard deviation, or number (%).
MELD score, model for end-stage liver disease score; KONOS, Korean Network for Organ Sharing; HBV-LC, HBV-associated liver cirrhosis; HCV-LC, HCV-associated liver cirrhosis; INR, international normalization ratio; HCC, hepatocellular carcinoma.

The detailed profiles of these recipients are summarized in Table 1. Primary liver diseases in this cohort included HBV-associated liver cirrhosis (n = 11), HCV-associated liver cirrhosis (n = 1), alcoholic liver disease (n = 6), acute and subacute liver failure (n = 4), cryptogenic liver cirrhosis (n = 1), primary sclerosing cholangitis (n = 1), and Budd-Chiari syndrome (n = 1). Three patients have enrolled as KONOS status 1 cases due to fulminant hepatic failure. The mean model for end-stage liver disease (MELD) score was 27.3 ± 10.9 and graft-recipient weight ratio (GRWR) was 1.98 ± 0.44. The cold ischemic time was 219.1 ± 119.4 minutes. One patient underwent repeated DDLT due to chronic graft failure at 131 days after the first transplantation.

The donor profiles are summarized in Table 2. The mean donor age was 26.5 ± 7.7 years. The split ERL graft weight was 1,181.5 ± 252.8 g, which resulted in a mean GRWR of 1.98 ± 0.44.

Fates of the retained S4 parenchyma

On the 1- or 2-week liver CT scans, the retained S4 parenchyma showed a small or scant amount of ischemic necrosis (6.7% ± 1.6% of the graft volume) in 16 of the study patients (64.0%) (Fig. 2), whereas the remaining 9 patients (36.0%) showed a large amount of S4 ischemic necrosis (14.6% ± 3.5% of the graft volume) (Fig. 3). One of these 9 cases with mottled ischemia of the right liver showed uneventful resolution of S4 ischemic necrosis but had progressively deteriorating graft function with development of ascites within the first year of the transplantation (Fig. 4). Another patient with a large amount of S4 ischemic necrosis underwent repeated DDLT due to chronic graft failure at 131 days after the first SLT (Fig. 5). The other patient underwent percutaneous middle hepatic vein stenting at posttransplant day 12 due to stenosis of the middle-left hepatic vein trunk (Fig. 6). One of the patients who showed a small amount of S4 ischemic necrosis (Case No. 3) experienced primary non-function and died on posttransplant day 7.

In 24 of our current study patients, excluding the primary non-function case, the posttransplant peak levels of serum liver enzymes in the large and small ischemic necrosis groups were AST of 2,808.6 ± 662.9 U/L and 457.6 ± 118.1 U/L, respectively (P = 0.001); and ALT of 831.3 ± 277.1 U/L and 432.9 ± 111.8 U/L, respectively (P = 0.002). The mean GRWR was 1.87 ± 0.43 in the 9 patients with a large amount of ischemic necrosis and 2.10 ± 0.44 in the other 15 patients with a small amount of ischemic necrosis (P = 0.283). The 3-month CT scans revealed that the retained S4 parenchyma was markedly reduced regardless of the amount of initial ischemic necrosis. The 1-year follow-up abdomen CT scans showed the complete disappearance of the S4 parenchyma in all surviving patients.

Table 2. Detailed profiles of the deceased donors for the adult split liver transplantation (SLT) patients

Case No.	Age (yr)	Sex	Height (cm)	Weight (kg)	BMI (kg/m^2)	Total bilirubin (mg/dL)	Peak AST (U/L)	Peak ALT (U/L)	SLT graft weight (g)	GRWR
1	13	M	155	50	20.8	0.7	233	470	1,070	1.57
2	14	M	176	64	20.7	0.9	68	61	1,000	1.94
3	15	M	160	53	20.7	0.5	32	37	1,100	1.65
4	15	F	168	53	18.8	0.9	100	32	810	1.89
5	17	M	169	70	24.6	2.2	60	118	1,141	1.31
6	18	M	177	80	25.4	0.8	42	22	1,280	1.78
7	21	M	178	65	20.5	0.6	22	21	1,050	2.05
8	23	F	165	56	20.6	1.7	112	160	1,220	1.73
9	24	M	171	67	22.9	0.8	60	52	1,259	1.89
10	26	F	160	49	19.1	0.3	37	38	990	1.71
11	27	M	171	84	28.9	2.4	65	74	1,480	2.20
12	28	M	172	71	24.1	2.4	85	122	1,200	1.87
13	28	F	165	55	20.2	0.6	190	98	1,300	1.91
14	29	M	175	66	21.6	1.3	24	26	950	1.57
15	29	F	158	64	25.5	0.5	24	21	1,096	2.74
16	31	F	162	58	22.0	0.5	287	752	990	2.73
17	31	F	180	87	26.9	0.3	68	39	2,000	2.41
18	32	M	173	67	22.3	0.4	27	28	912	1.74
19	32	F	158	50	20.1	0.3	27	19	970	1.36
20	33	M	175	70	22.8	1.5	70	46	1,550	2.83
21	33	F	163	56	21.0	2.4	85	122	1,010	1.67
22	34	M	185	53	15.5	1.5	34	28	1,190	1.91
23	35	M	178	73	23.0	2.4	85	122	1,470	2.67
24	37	M	172	75	25.4	2.2	122	171	1,360	2.54
25	38	M	170	69	23.8	0.9	27	19	1,140	1.82
Mean	26.5 ± 7.7	M = 16, F = 9	169.6 ± 8.0	64.5 ± 10.9	22.3 ± 2.9	1.16 ± 0.78	79.4 ± 67.3	107.9 ± 163.5	1,181.5 ± 252.8	1.98 ± 0.44

BMI, body mass index; GRWR, graft-recipient weight ratio; M, male; F, female.

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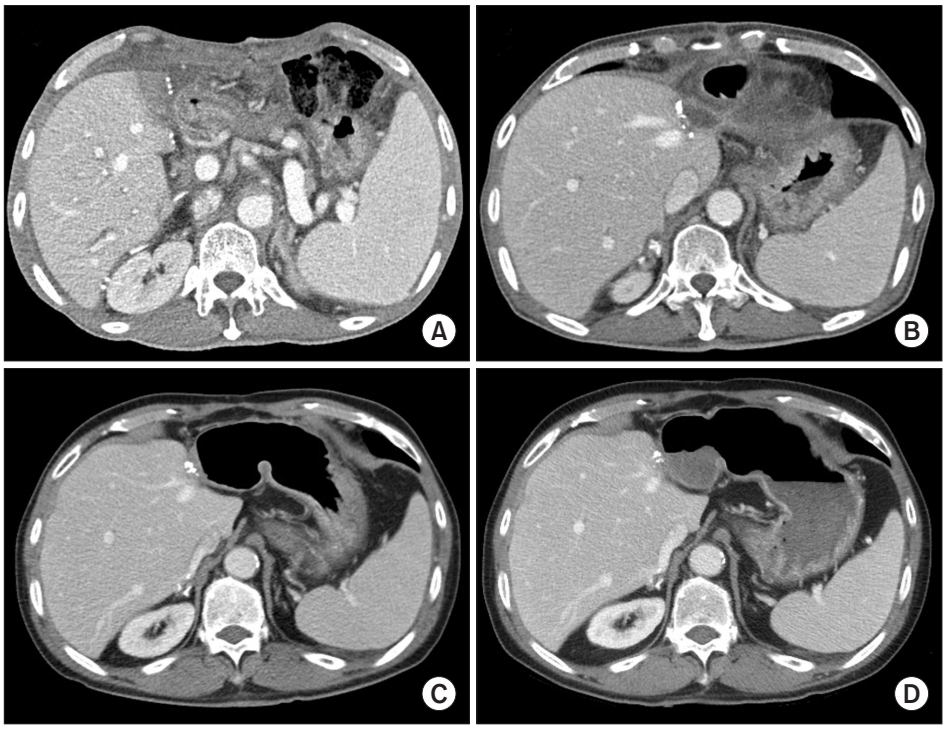

Fig. 2. Follow-up CT scan revealing a small amount of ischemic necrosis at the retained segment IV (S4) parenchyma. A CT scan at 1-week posttransplant (A) indicated a small amount of ischemic necrosis. Follow-up CT scans taken at 1 month (B), 1 year (C), and 2 years (D) posttransplant revealed progressive atrophy and eventual disappearance of the retained S4 parenchyma.

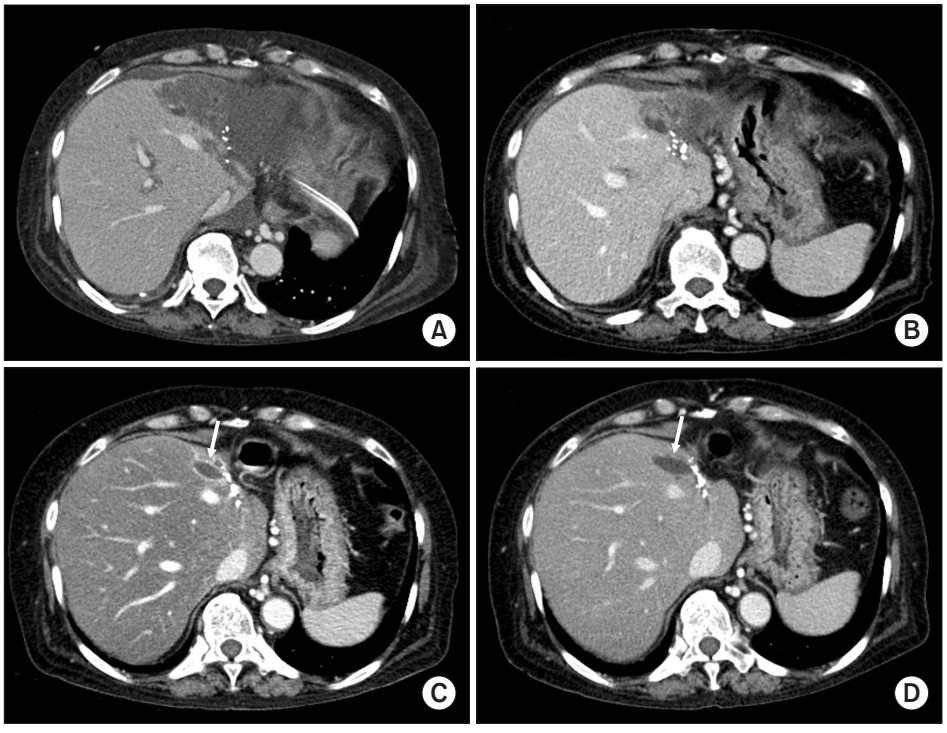

Fig. 3. Follow-up CT scan showing a large amount of ischemic necrosis at the retained segment IV (S4) parenchyma. A CT scan at 1-week posttransplant (A) indicated a large amount of ischemic necrosis. Follow-up CT scans taken at 1 month (B), 8 months (C), and 18 months (D) posttransplant revealed progressive atrophy and eventual disappearance of the retained S4 parenchyma. Only a dilated S4 bile duct remnant was identifiable (arrows).

Graft and patient survival outcomes

The 3-month, 1-year, 3-year, 5-year, and 10-year graft survival rates were 88.0%, 76.0%, 71.5%, 71.5%, and 61.3%, respectively (P = 0.721) (Fig. 7A). The 3-month, 1-year, 3-year, 5-year, and 10-year overall patient survival rates were 88.0%, 80.0%, 75.6%, 75.6%, and 66.1%, respectively (Fig. 7B). The 3 cases of in-hospital mortality were caused by primary non-function (n = 1), multiorgan failure (n = 1), and acute respiratory

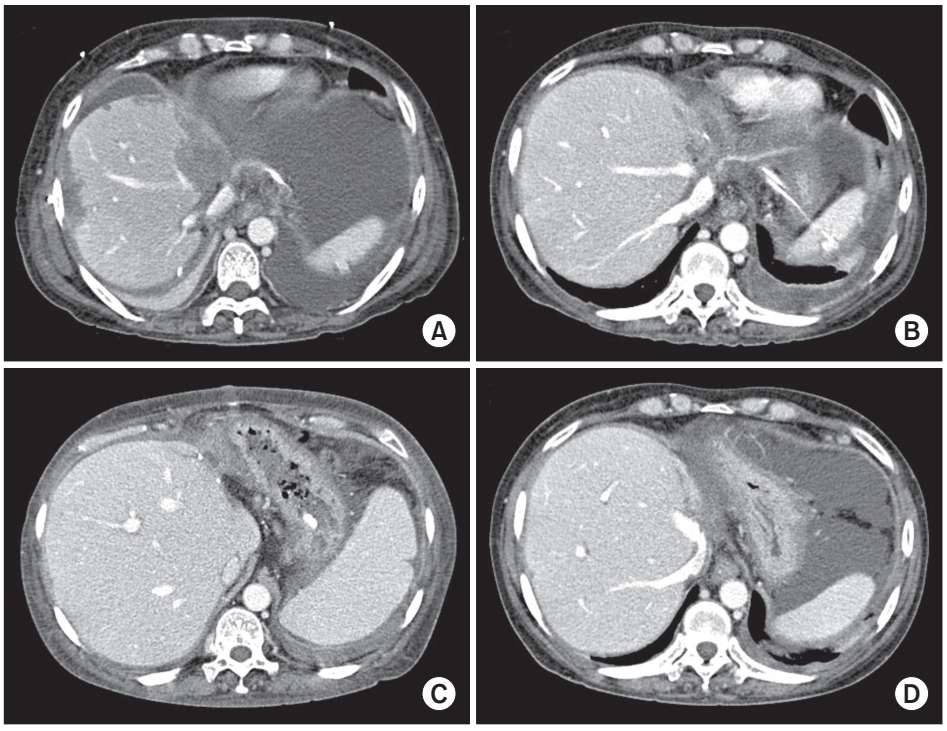

Fig. 4. Follow-up CT scan indicating a large amount of ischemic necrosis at the retained segment IV parenchyma (S4) and the late development of graft dysfunction. A CT scan at 1-week posttransplant (A) revealed a large amount of S4 ischemic necrosis and mottle ischemia at the right liver. Follow-up CT scans at 1 month (B) and 3 months (C) posttransplant revealed progressive disappearance of the ischemic areas. Notably, however, ascites development was evident on the 8-month CT scan (D).

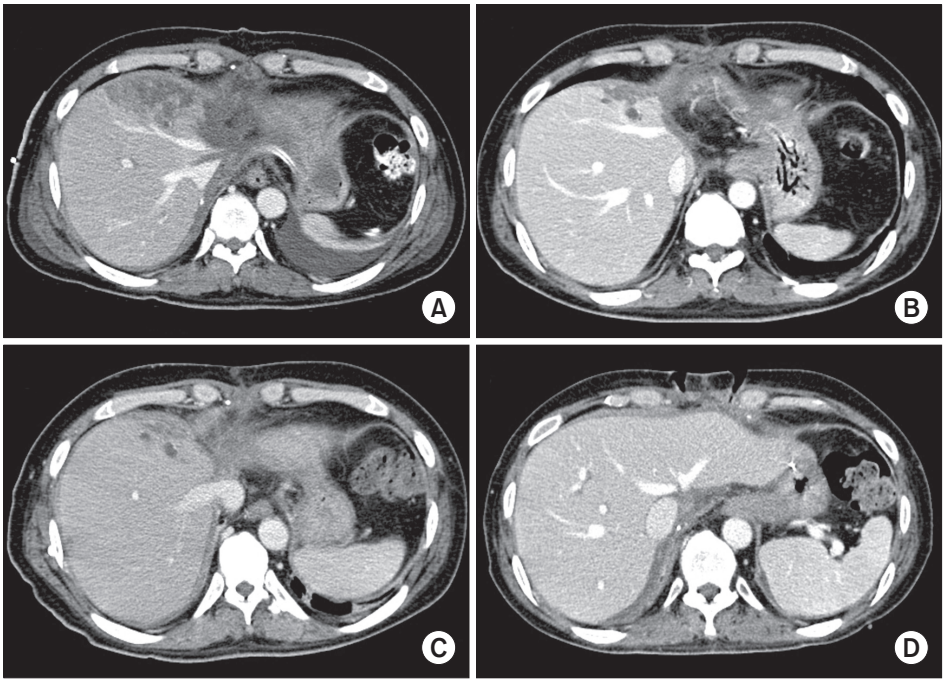

Fig. 5. Follow-up CT scan revealing a large amount of ischemic necrosis at the retained segment IV (S4) parenchyma and the development of late graft dysfunction that required retransplantation after 131 days. A CT scan at 1-week posttransplant (A) indicated a large amount of S4 ischemic necrosis. Follow-up CT scans at 1 month (B) and 3 months (C) posttransplant revealed progressive disappearance of the ischemic areas. However, graft function deteriorated progressively in this patient, and retransplantation was performed using a whole liver graft (D).

distress syndrome (n = 1). The causes of late mortality in further 4 patients were pneumonia (n = 1), posttransplant lymphoproliferative disease (n = 1), hepatocellular carcinoma recurrence (n = 1), and general condition deterioration combined with dementia (n = 1). In the 24 patients in our current series, excluding the single primary non-function case, there was no difference in graft survival (P = 0.592) (Fig. 7C) or overall patient survival (P = 0.243) (Fig. 7D) between the small and large ischemic necrosis groups.

In all 25 patients in our current cohort, stratification using MELD score of >30 and ≤30 revealed a marginal difference in graft survival (P = 0.067) and a significant difference in overall

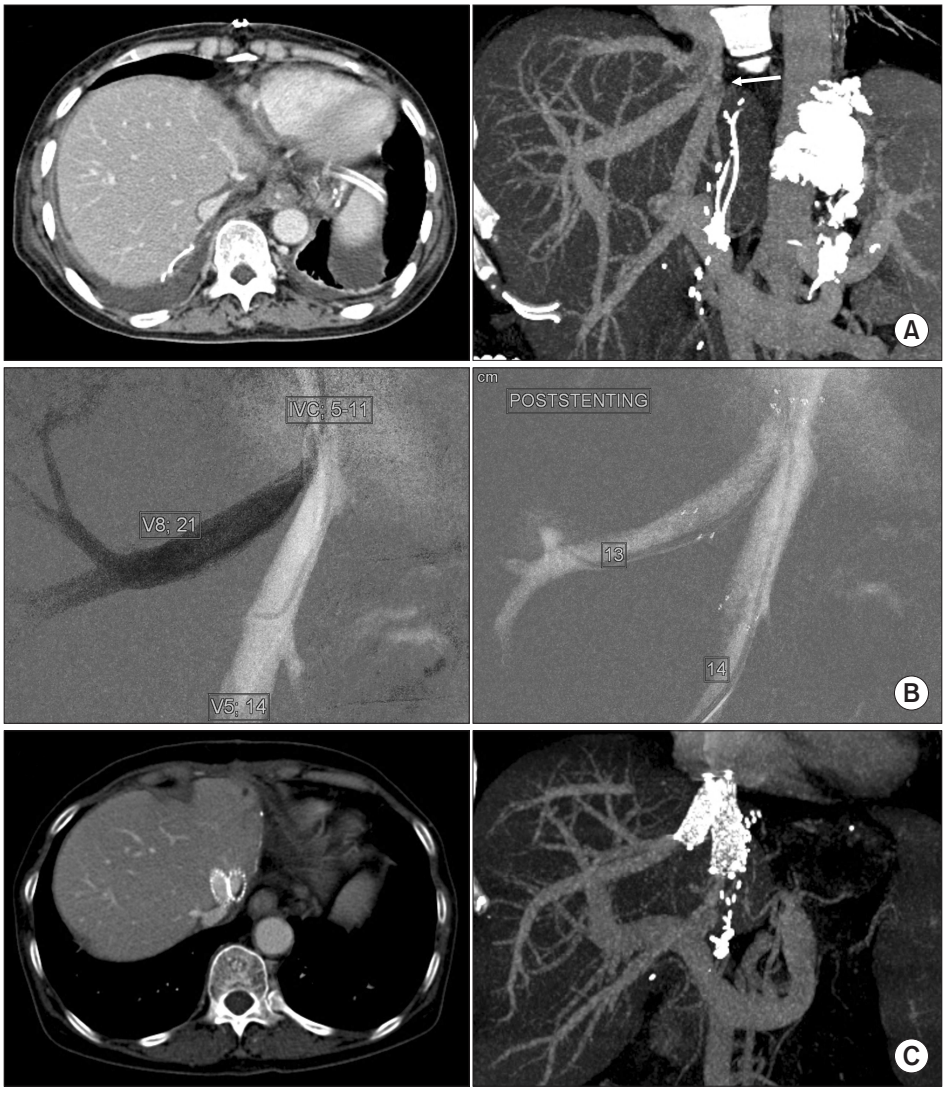

Fig. 6. Follow-up CT scan showing a small amount of ischemic necrosis at the retained segment IV (S4) parenchyma with development of stenosis at the middle-left hepatic vein trunk. A follow-up CT scan at 1 month posttransplant (A) indicated a small amount of S4 ischemic necrosis but revealed development of stenosis at the middle-left hepatic vein area (arrow). The intravascular pressures of the segment VIII hepatic vein branch (21 cmH_2O) and middle hepatic vein trunk (14 cmH_2O) were elevated, and percutaneous hepatic vein stenting was therefore performed at posttransplant day 12. The intravascular pressure was then decreased (B). A follow-up CT scan taken at 6 months showed patent blood outflows within the wall stents (C).

patient survival (P = 0.022) (Fig. 8A). Pretransplant requirement for ventilator support was associated with poorer outcomes in graft survival (P < 0.001) and in overall patient survival (P = 0.012) (Fig. 8B). Pretransplant requirement for renal replacement therapy had a marginal association with poorer graft survival (P = 0.053) but not with overall patient survival (P = 0.271) (Fig. 8C). Multivariate analysis using MELD score of >30 and pretransplant ventilator support indicated that ventilator support was an independent risk factor for graft survival but that neither of these factors was an independent risk factor for patient survival (Table 3).

DISCUSSION

Since the first child-adult SLT was conducted in Korea in 1998 [20], the number of SLT cases has remained small but has been gradually increasing. There are 2 major reasons for the eventual increase in SLT procedures in Korea. One is the progressive increase in the number of deceased donors which has resulted in a gradually higher number of donor candidates for SLT [21]. Notably, however, the number of SLT cases has begun to decrease more recently due to various social issues [22,23]. Another reason for the overall increase in SLT procedures was changes in allocation policy. Until 2012, a child DDLT candidate could only be listed as an SLT candidate if the parents were not suitable donors [24]. Since 2013 however, registering on the SLT waiting list has been open to every pediatric candidate on the DDLT waiting list [5].

With regard to adult recipients of split ERL grafts, posttransplant outcomes are of more concern for transplant surgeons than with whole liver transplant procedures. In a prior Korean multicenter study, the risk factors for poorer patient survival outcomes in SLT recipients were GRWR of ≤1.0 and MELD score of >30 [5]. The mean GRWR in our present study

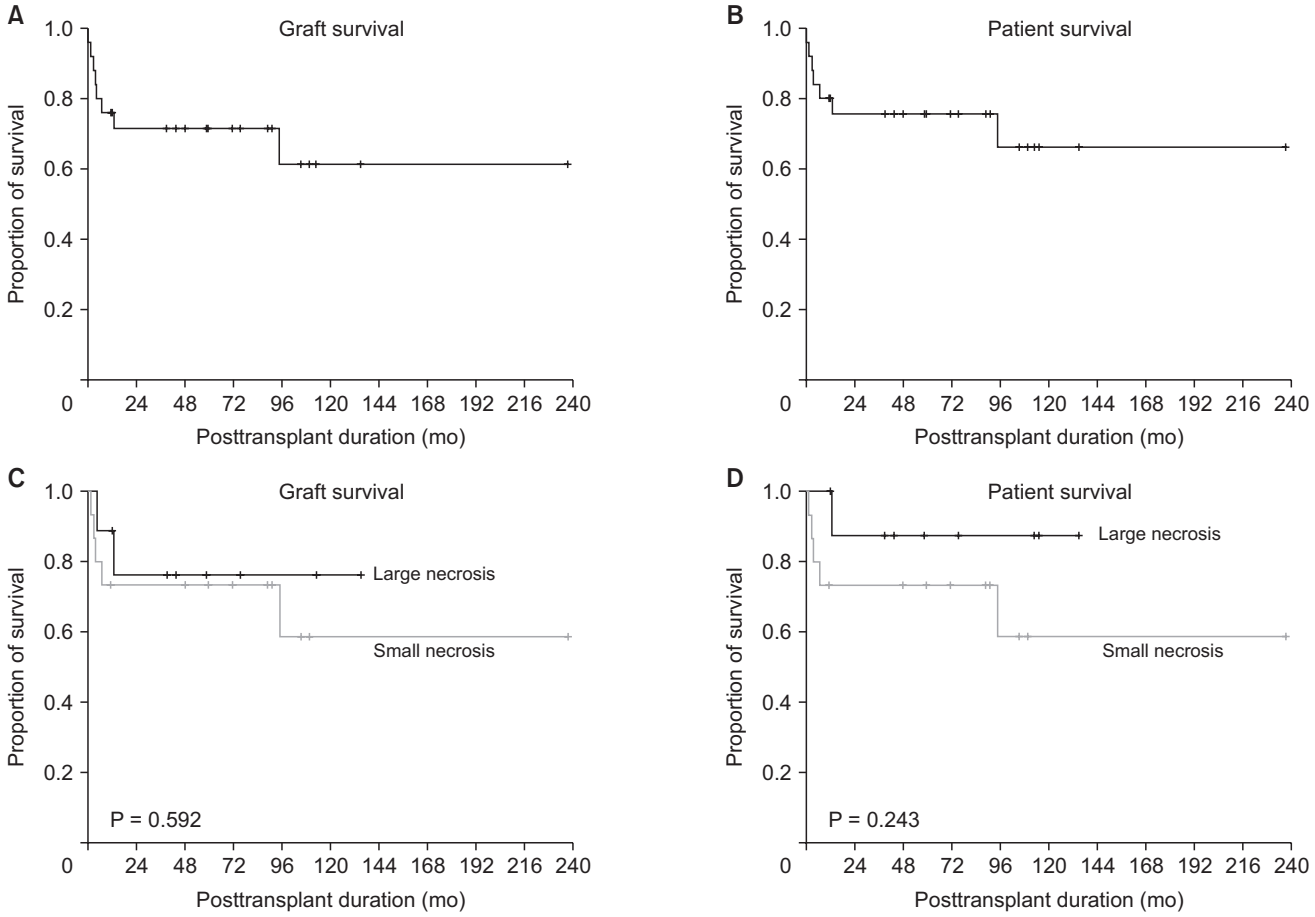

Fig. 7. Survival curves after split liver transplantation (SLT). Survival in all 25 study cases of SLT: Graft survival curve (A) and overall patient survival curve (B). Comparison of the survival curves of the 24 cases of SLT, with the exclusion of one patient with primary non-function, in accordance with the amount of ischemic necrosis at the segment IV parenchyma: Comparisons using graft survival (C) and overall patient survival (D) curves.

was 1.98 ± 0.44 with a range of 1.31–2.83, thus the GRWR did not become a risk factor. In contrast, patients in our study cohort with MELD scores of >30 showed inferior outcomes, thus being a potential risk factor. Careful patient selection is therefore essential to improve the outcomes of SLT.

With regard to the GRWR in cases of SLT using an ERL graft, the amount of S4 ischemia is known to be an important factor for determining actual GRWR. Since nearly all of the retained S4 parenchyma will undergo ischemic necrosis, it is reasonable to extract the volume of the S4 parenchyma from the ERL graft volume to estimate the actual GRWR. In addition, ischemic necrosis of the S4 parenchyma generates an additional metabolic burden on graft liver function, and a larger retained S4 parenchyma can therefore increase the risk of patient morbidity. Consequently, some authors have proposed the preemptive removal of the S4 during SLT operation [16-18]. Adult SLT recipients of ERL grafts in our present series with a larger retained S4 showed a greater elevation of their liver enzyme levels, consistent with a prior literature review [25]. Notably, however, the amount of ischemic necrosis of the retained S4 parenchyma was not a significant risk factor in our current study cohort, probably because the GRWR was sufficiently high in these patients to compensate for any graft volume loss from this necrosis.

Biliary leak from the graft liver cut surface has also been reported to be one of the retained S4-associated major complications [14,15,25]. If the blood supply to the retained S4 parenchyma partially remains, it can induce bile production in the retained S4 parenchyma. Consequently, the intraluminal pressure of the S4 bile ducts increases and leads to eventual leak from the ligated bile duct stumps. We previously reported a case of S4 resection due to intractable bile leak after donation of a LLS graft in a living donor [13]. We did not experience such S4-associated biliary leak among our present study cases because we had applied 2 technical tips during *in situ* splitting. We derived this approach from pediatric LDLT methods using a LLS graft. The first part of this technique is ligation of the S4 hepatic artery at the ERL side, which is usually the middle

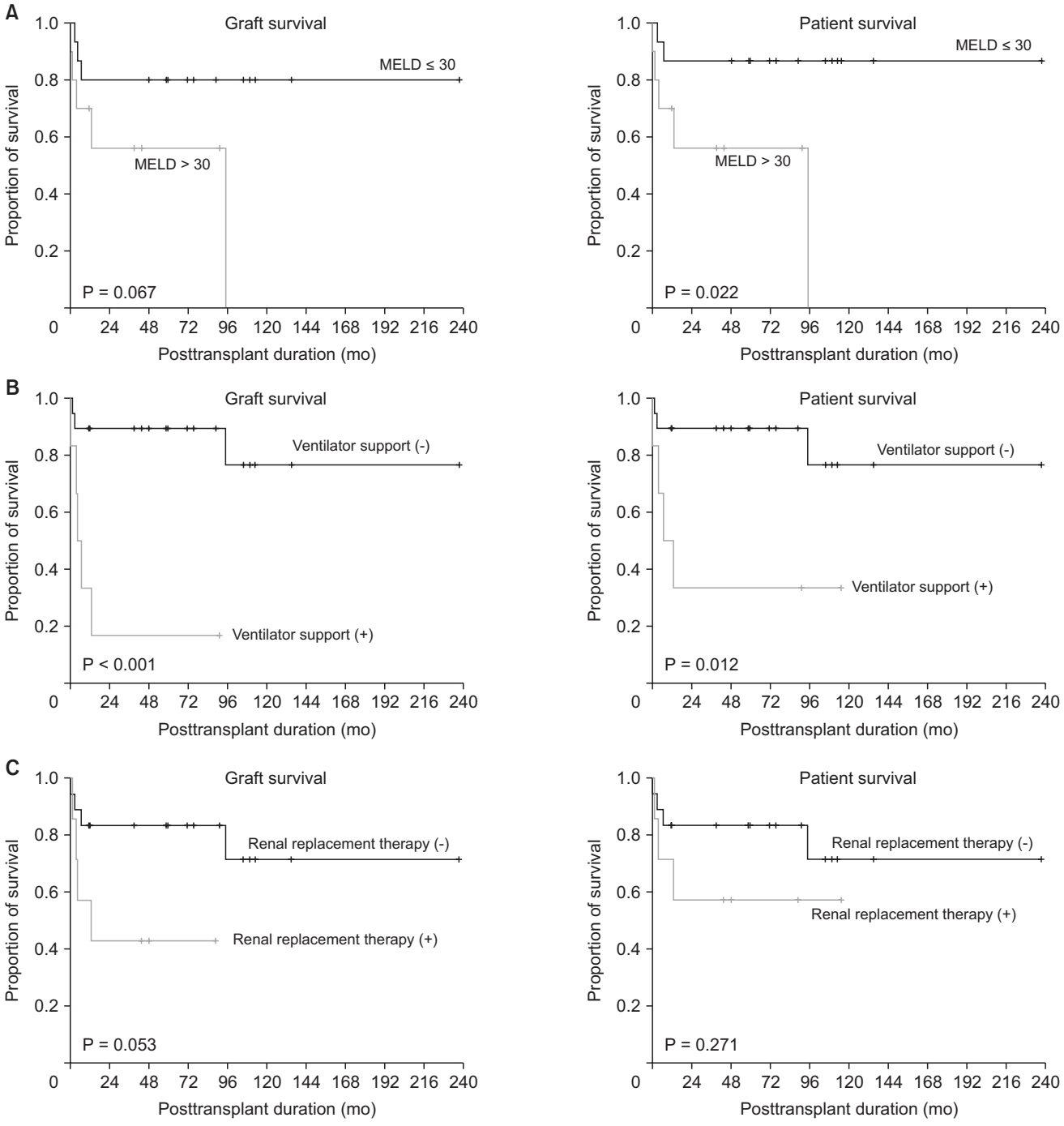

Fig. 8. Comparison of the survival curves of the 25 study cases of split liver transplantation. (A) Comparison of graft and overall patient survival curves according to the model for end-stage liver disease (MELD) score with a cutoff of 30. (B) Comparison of the graft and overall patient survival curves according to the pretransplant requirement for ventilator support. (C) Comparison of the graft and overall patient survival curves according to the pretransplant requirement for renal replacement therapy.

hepatic artery. This S4 artery is usually not encapsulated by the Glissonian sheath and its intentional identification and ligation are thus necessary [18]. The second part is secure ligation of the S4 Glissonian branches at the retained S4 parenchyma. Multiple ligations of the separate Glissonian branches are helpful to secure the bile duct stump closure.

If a patient survives after SLT operation, the retained S4 parenchyma will undergo progressive ischemia-inducing parenchymal atrophy during the first few months posttransplantation. One-year follow-up CT scan images of our current study cases indicated that all ERL grafts with retained S4 parenchyma of variable sizes had converted to a true ERL

Table 3. Univariate and multivariate analyses of adult patient survival who underwent split liver transplantation

Parameter	Case No.	Univariate analysis		Multivariate analysis	
		One-year patient survival rate (%)	P-value	HR (95% CI)	P-value
Graft survival					
MELD score					
≤30	15	80.0		1	
>30	10	70.0	0.067	1.93 (0.39–9.52)	0.420
Pretransplant ventilator support					
No	19	89.5		1	
Yes	6	33.3	<0.001	8.47 (1.49–47.6)	0.016
Patient survival					
MELD score					
No	15	86.7		1	
Yes	10	70.0	0.022	4.46 (0.74–27.1)	0.102
Pretransplant ventilator support					
No	19	89.5		1	
Yes	6	50.0	0.012	4.0 (0.83–19.23)	0.083

CI, confidence interval; MELD score, model for end-stage liver disease score.

graft with complete disappearance of the S4 parenchyma. However, patients that underwent overt ischemic necrosis of the S4 parenchyma usually showed a high elevation of liver enzyme levels during the early posttransplant period. Although our current results did not statistically support the detrimental effect of overt ischemic necrosis of S4 parenchyma, its potential negative prognostic impact cannot be ignored [25].

The size of the retained S4 parenchyma depends on the anatomy of the donor liver S4 and also the body size of a pediatric recipient. If the pediatric recipient is an infant with bodyweight of less than 10 kg, the donor surgeons will attempt to make the LLS graft as small as possible. Consequently, a majority of the S4 parenchyma will be retained at the right liver side. If the S4 volume is anatomically large, a considerable mass of S4 also remains. If the body size of a pediatric recipient is large, the donor surgeons will try to make the LLS graft as large as possible and it then becomes comparable to a left liver graft without a middle hepatic vein trunk. As a result, only a small amount of S4 parenchyma will be retained. Hence, if large-sized S4 parenchyma is retained and overt dark discoloration indicating complete inflow occlusion is identified, and the split ERL graft appears sufficiently large relative to the body size of an adult recipient, it is theoretically reasonable to remove the retained S4 parenchyma just after *in situ* splitting as a preemptive approach to preventing S4-associated complications.

In the present study, 1 patient who showed a small amount of S4 ischemic necrosis experienced primary non-function. The donor was a 15-year-old male with normal preoperative liver function test. The cold and warm ischemic times were 350 minutes and 73 minutes, respectively. We presumed that one of the underlying causes of primary non-function might be hemodynamic instability of the recipient with very poor peritransplant condition. Considering that the GRWR was 1.65 and S4 ischemic necrosis was small, liver splitting *per se* might not be associated with occurrence of primary non-function in this patient.

This study had some limitations of note. In the first instance, it was a retrospective, single-center study with a small number of patients. Moreover, the performance of the SLT was decided on case-by-case basis and thus there were no established guidelines for this procedure. Further high-volume multicenter studies are necessary to validate our present findings.

In conclusion, the amount of ischemic necrosis of the retained S4 parenchyma is not a negative prognostic indicator in adult SLT recipients, likely due to sufficiently large GRWR. However, a high MELD score (>30) and pretransplant ventilator support are closely associated with inferior outcomes in these cases. Therefore, careful selection of donors and recipients is essential to improve the outcomes of adult SLT.

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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