LETTER TO THE EDITORS

Initial experience of laparoscopic living donor hepatectomy for pediatric liver transplantation in a Southeast Asian transplant center

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Dear Editors,

The recent Morioka consensus conference [1] and a subsequent expert panel statement published by Han *et al.* [2] suggest that the laparoscopic approach for donor left lateral sectionectomy (LLLS) should be the standard of care for pediatric donors. However, its adoption has been reserved in many transplant centers because of concerns of donor morbidity and the steep learning curve. The National University Hospital of Singapore is the only pediatric liver transplant center in Singapore and also serves patients in the Southeast and South Asian region. We are a medium-sized liver transplant center that performs approximately 25–40 liver transplants per year, of which a significant proportion are living donation. Prior to the first LLLS, we have performed more than 173 cases of laparoscopic liver resections and major hepatectomies constitute 22.0% of cases (n = 38). We performed our first LLLS in November 2017 and have since done five cases over a 1-year period. We would like to share our center's experience in the development and transition to LLLS with the first five cases of LLLS, and seek to compare the outcomes of LLLS with the open approach for living donor left lateral sectionectomy (OLLS).

To optimize the chances of success, donors were carefully selected for the initial cases and donors with body mass index >30.0 were excluded. Patients with anatomical variations in their hepatic artery (HA), portal vein (PV), hepatic vein (HV), and bile duct were also avoided in the first three cases. Their characteristics and outcomes were compared with all 30 OLLS patients between September 2011 and November 2018.

While the technique used with all 5 LLLS cases was relatively standard, there were particular modifications made because of anatomy or specific donor or recipient requirements. We utilized the cavitron ultrasonic surgical aspirator (CUSA) in all cases for parenchymal transection. The use of CUSA for dissection close to the origin of the left HV allowed us to maximize the length of the left HV for recipient graft implantation as we found that the use of a vascular stapler to divide the left HV will inevitably result in a shorter left HV stump for anastomosis. In the second case, the recipient was a small infant, and thus, the final graft-to-recipient weight ratio was 3.70%. Intraoperative graft reduction was performed using a harmonic scalpel to reduce the graft size by 30%. For the third case, we employed indocyanine green (ICG) fluorescence imaging to assist with visualization of the biliary tree. We found that the findings from ICG corroborated well with intraoperative cholangiogram (IOC) and assisted in determining the optimal bile duct division points. Compared with IOC, it is also easier to perform as it does not involve bile duct cannulation, is safe as no radiation is required, and is potentially superior as it shows biliary anatomy from various angles which can help in understanding 3-dimensional spatial direction and relationships of structures around the hilar plate at any point during the surgery [3]. Its use can potentially reduce biliary complications during donor hepatectomy, but further experience is required to determine its safety and efficacy. There were HA anatomical variations in the last two cases, whereby the left HA originated from the left gastric artery in the fourth case while an extra accessory left HA was present in the fifth case. In the fifth case, a decision was made to anastomose the accessory left HA to the recipient's native left HA and ligate the graft main left HA, as the graft main left HA was small while the accessory left HA was appropriately sized.

All 5 donors recovered well without significant morbidity and no mortality. Patient 3 had bleeding from the Pfannenstiel incision at the anterior abdominal wall which stopped spontaneously. The median operative

doi:10.1111/tri.13565

time (300 vs. 400 min; $P = 0.021$) and parenchymal transection time (55 vs. 144 min; $P < 0.001$) were significantly shorter in the LLLS group. LLLS patients had less postoperative pain (4 vs. 6, $P = 0.22$) and quicker return to premorbid ambulatory status (1 vs. 2 days, $P = 0.001$) and lifestyle (30 vs. 40 days, $P = 0.001$). Details of comparison of postoperative donor outcomes can be found in Table 1a. Adjusting for ASA, age, BMI, sex, and graft volume, patients in LLLS group were found to have significantly shorter operative time ($\beta = -0.396$, $P = 0.021$), parenchymal transection time ($\beta = -0.606$, $P = 0.001$), and duration of stay in high-dependency unit ($\beta = -0.398$, $P = 0.031$). They also had faster return to premorbid ambulatory status ($\beta = -0.431$, $P = 0.018$) and lifestyle ($\beta = -0.552$, $P = 0.001$). The results of the multivariate analysis are

Table 1. (a) Comparison of LLLS and OLLS groups. (b) Univariate and multivariate analyses comparing outcomes of LLLS vs. OLLS.

	LLLS*n* = 5(% or range)	OLLS(*n* = 30)(& or range)	*P*-value
(a)			
Donor and graft characteristics			
Donor age (years)	35 (29–52)	35 (24–49)	0.981
Sex			
Male	2 (40.0)	17 (56.7)	0.489
Female	3 (60.0)	13 (43.3)	
Body mass index (BMI)	21.0 (19.7–25.8)	24.5 (18.0–37.5)	0.114
ASA class			
I	3 (60.0)	26 (86.7)	0.143
II	2 (40.0)	4 (13.3)	
Graft volume evaluation on CT (ml)	205 (133–312)	257 (168–461)	0.151
Details of surgery			
Median operative time (min)	300 (270–420)	420 (260–540)	**0.021**
Median parenchymal transection time (min)	55.0 (45.0–80.0)	144.5 (65.0–276.0)	**<0.001**
Median blood loss (ml)	300 (50–300)	300 (50–600)	0.210
Drain inserted	1 (20.0)	4 (13.3)	0.693
Postoperative donor outcomes			
Hemoglobin drop (g/dl)	1.4 (0.7–4.8)	2.3 (0.1–4.1)	0.238
Postoperative morbidity	1 (20.0)	5 (16.7)	0.855
Length of stay, high-dependency unit (day)	2 (0–3)	2 (1–5)	0.086
Length of stay, total (day)	5 (4–7)	5 (4–9)	0.535
Postoperative day 1 pain at rest	4 (0–5)	6 (2–9)	**0.022**
Days to ambulation	1 (1–2)	2 (1–3)	**0.001**
Days to bowel movement	3 (2–4)	3 (2–5)	0.338
Days to return to premorbid lifestyle	30 (20–35)	40 (30–55)	**0.001**

Factor	Univariate *P*	Multivariate analysis *B*	95% CI	β	*P*
(b)					
Operative time (min)	**0.021**	−79.014	−145.189 to −12.840	−0.396	**0.021**
Parenchymal transection time (min)	**<0.001**	−99.118	−154.254 to −43.983	−0.606	**0.001**
Blood loss	0.210	−112.399	−271.432 to 46.635	−0.282	0.159
Drains	0.693	0.056	−0.376 to 0.487	0.056	0.793
Hemoglobin drop	0.238	−0.255	−1.454 to 0.944	−0.081	0.666
Morbidity	0.855	−0.066	−0.501 to 0.370	−0.061	0.760
Length of stay, high-dependency (day)	0.086	−1.074	−2.039 to −0.109	−0.398	**0.031**
Length of stay, total (day)	0.535	−0.241	−1.512 to 1.031	−0.078	0.701
Postoperative day 1 pain	**0.022**	−1.660	−3.488 to 0.169	−0.327	0.073
Days to ambulation	**0.001**	−0.507	−0.919 to −0.095	−0.431	**0.018**
Days to bowel movement	0.338	−0.485	−1.462 to 0.491	−0.204	0.317
Days to premorbid lifestyle	**0.001**	−10.768	−16.558 to −4.977	−0.552	**0.001**

*Bolded values - $p < 0.05$, statistically significant results.

illustrated in Table 1b. All recipients are currently in excellent health with normally functioning grafts.

The results of our initial experience with LLLS show that it is a safe procedure with significant benefits for the donor. Postoperative pain was significantly lower, which likely accounted for the earlier return to ambulation and premorbid lifestyle. Furthermore, the additional cosmetic benefit and reduced wound-related complications from smaller incisions and the Pfannenstiel incision [4,5] for graft extraction were touted by patients, especially for young donor parents. The positive results from our initial experience were contributed by our prior experience and familiarity with both major laparoscopic hepatectomies and liver transplant surgery. We suggest that LLLS only be attempted in centers with an established laparoscopic hepatectomy program to minimize the risks of donor morbidity. Furthermore, careful selection of suitable donors with standard anatomy for the initial cases is essential to the success of the LLLS program. This is especially true in a medium-sized transplantation program such as ours.

The positive results from our initial experience with donor LLLS as a medium-sized transplantation center will hopefully encourage more centers to scale the learning curve for donor LLLS. Moving forward, our center will attempt laparoscopic donor right hepatectomies (LDRHs), which may soon become the standard of care in adult donor hepatectomies as established liver transplant centers continue to publish series of LDRHs with encouraging outcomes [6–8].

Conflict of interest

The authors have no conflict of interests or sources of funding to declare.

REFERENCES

1. Wakabayashi G, Cherqui D, Geller DA, *et al*. Recommendations for laparoscopic liver resection: a report from the second international consensus conference held in Morioka. *Ann Surg* 2015; **261**: 619.
2. Han HS, Cho JY, Kaneko H, *et al*. Expert panel statement on laparoscopic living donor hepatectomy. *Dig Surg* 2018; **35**: 284.
3. Hong SK, Lee K, Kim H, *et al*. Optimal bile duct division using real-time indocyanine green near-infrared fluorescence cholangiography during laparoscopic donor hepatectomy. *Liver Transpl* 2017; **23**: 847.
4. Nguyen KT, Gamblin TC, Geller DA. World review of laparoscopic liver resection-2,804 patients. *Ann Surg* 2009; **250**: 831.
5. Luijendijk RW, Jeekel J, Storm RK, *et al*. The low transverse Pfannenstiel incision and the prevalence of incisional hernia and nerve entrapment. *Ann Surg* 1997; **225**: 365.
6. Suh KS, Hong SK, Lee KW, *et al*. Pure laparoscopic living donor hepatectomy: focus on 55 donors undergoing right hepatectomy. *Am J Transplant* 2018; **18**: 434.
7. Kim KH, Kang SH, Jung DH, *et al*. Initial outcomes of pure laparoscopic living donor right hepatectomy in an experienced adult living donor liver transplant center. *Transplantation* 2017; **101**: 1106.
8. Samstein B, Griesemer A, Halazun K, *et al*. Pure laparoscopic donor hepatectomies: ready for widespread adoption? *Ann Surg* 2018; **268**: 602.