青岛大学附属医院
THE AFFILIATED HOSPITAL OF QINGDAO UNIVERSITY

Application of Hisense CAS to assess donor liver volume for living donor and split liver transplantation

Feng Wang, Imran Muhammad, Xin Wang, Yong Zhang, Bin Wu,Yandong Sun, Qingguo Xu, and Jinzhen Cai.

Organ Transplantation Center
The Affiliated Hospital of Qingdao University
Qingdao，China

Objective

The effectiveness of liver transplantation depends on a precise estimation of the donor's liver volume, particularly in the case of split and living donor liver transplantation. In this research, the volume of the divided donor liver was assessed, and accurate surgical planning was made using the Hisense Computer Assisted Surgery System (Hisense CAS).

Method

We used Hisense CAS to rebuild the donor liver based on the preoperative CT images, and clear 3D pictures of the donor liver's volume, vessels, and duct were provided. After that, the volume of the divided liver which included the left lateral lobe, right three lobes, left half, and right half was measured. This measurement was then compared and examined with the real volume that was taken during surgery. We also acquired the post-operative changes in liver volume regeneration using the system at the same time.

Hisense CAS and Basic characteristics of donors, recipients' graft usage
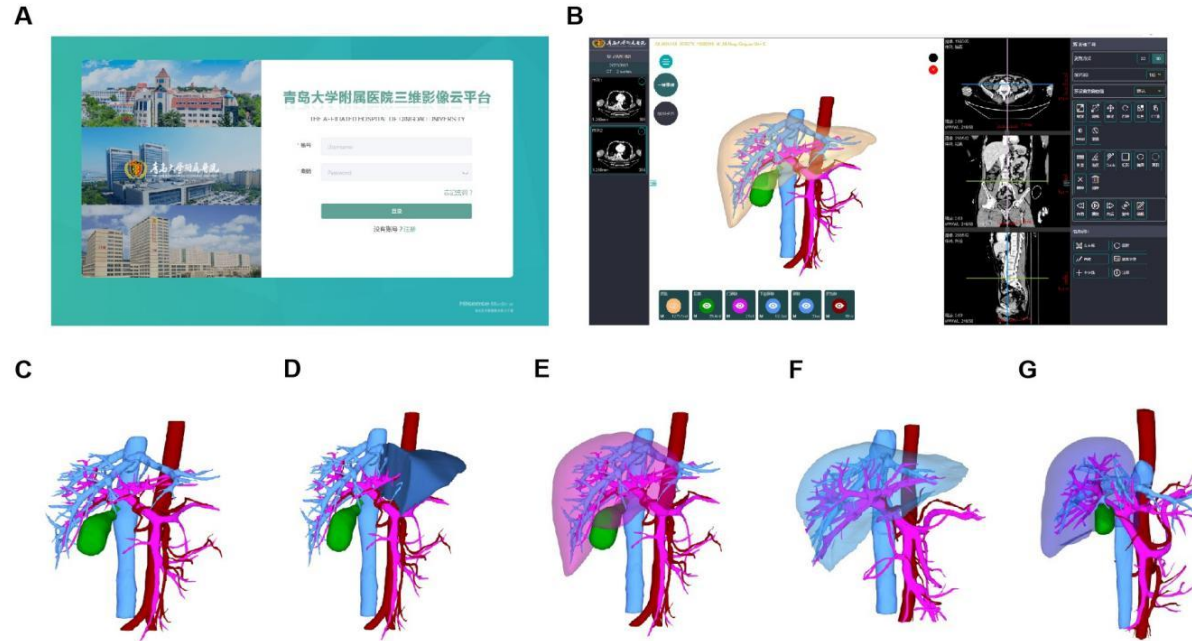

Figure 1. Hisense CAS and donor liver reconstruction. Hisense CAS login interface (A). CT or DCE-CT scans were done before surgery, a digital liver 3D model was established for each donor using Hisense CAS, which displayed the 3D anatomical relationship between the liver and its vessels (B and C). The left lateral lobe, right three lobes, right half, and left half of the donor liver were split up, and the volumes were clearly evaluated (D-G).
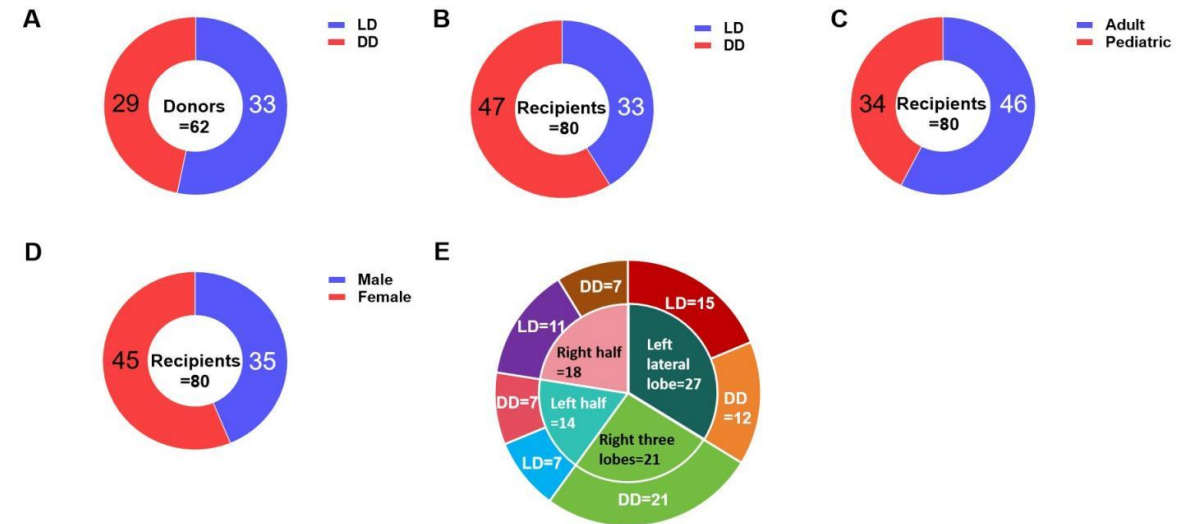
Figure 2. Basic characteristics of donors, recipients' graft usage. LD and DD donors' division (A). The case number of LD and DD graft recipients (B). The case number of adult and pediatric recipients (C). (D) The case number of male and female recipients (D). (E) The case number of recipients included for the left lateral lobe (LD and DD), the right three lobes (DD), the left half liver (LD and DD), and the right half liver (LD and DD) (E).

Recipients' basic clinical data and liver function

Table 1. The basic clinical character of splitting and living donor liver recipients (n=80)

Clinical character		The pediatric group（age<18）(n =35)	The adult group (age ≥18) (n =45)
Age, (years)		4.04±5.04(0.38-17.00)	48.89±12.54(20-74)
Gender	Male	20(57.14%)	12(26.67%)
	Female	15(42.86%)	33(73.33%)
BMI(kg/m²)		17.43±3.24 (13.00-30.50)	20.85±3.22(13.3-28.0)
Child-Pugh	A	9(25.70%)	3(6.70%)
	B	17(48.60%)	22(48.90%)
	C	9(25.70%)	20(44.40%)
PELD/MELD	PELD	18.67±10.18(0-32, n=30) (age<12)	
	MELD	9.20±1.79 (8-12, n=5) (age≥12)	14.62±7.45 (5-35, n=45)
ICU stay(days)		9.51±18.07(1.54-104.54)	5.83±4.61(1.58-23.83)

Table 2. The liver transplantation (LT) etiology of splitting and living donor liver recipients (n=80)

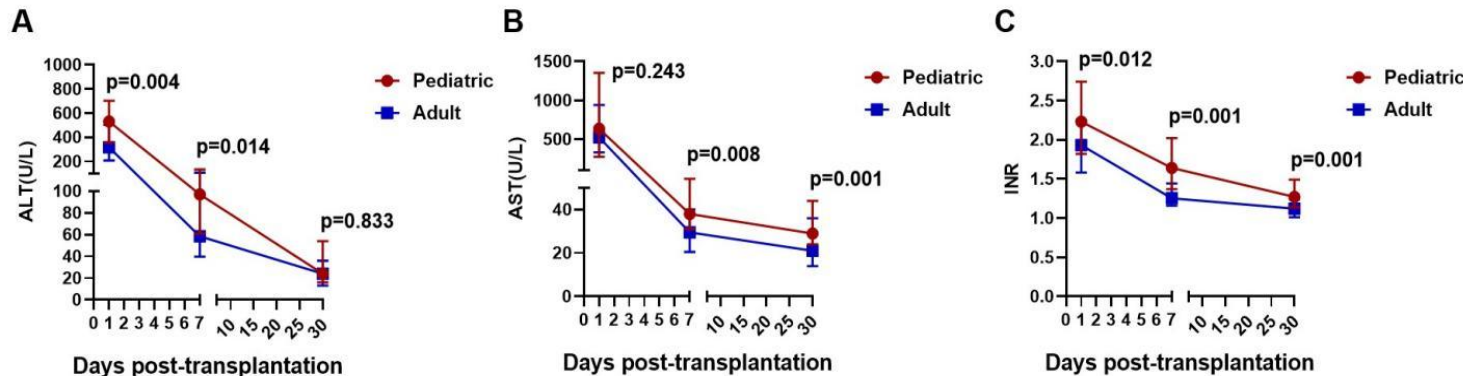|	LT Etiology	
Pediatric group(age<18) (n=35)	Biliary Atresia	21(60.0%)
	Liver cirrhosis	3(8.57%)
	Ornithine Transcarbamylase Deficiency	2(5.71%)
	Other causes	9(25.72%)
Adult group (age ≥18) (n=45)	Autoimmune Hepatitis	15(33.33%)
	Hepatitis B	13(28.89%)
	Malignant Liver Tumor	8(17.78%)
	Liver cirrhosis	3(6.67%)
	Acute hepatic failure	2(4.44%)
	Other causes	4(8.89%)

Figure 3. Liver function post liver transplantation. Results of adult and pediatric recipients' ALT from day1 to day30 (A). Results of adult and pediatric recipients' AST from day1 to day30 (B). Results of adult and pediatric recipients' INR from day1 to day30 (C).

Comparative analysis of evaluated and the real split donor liver volume
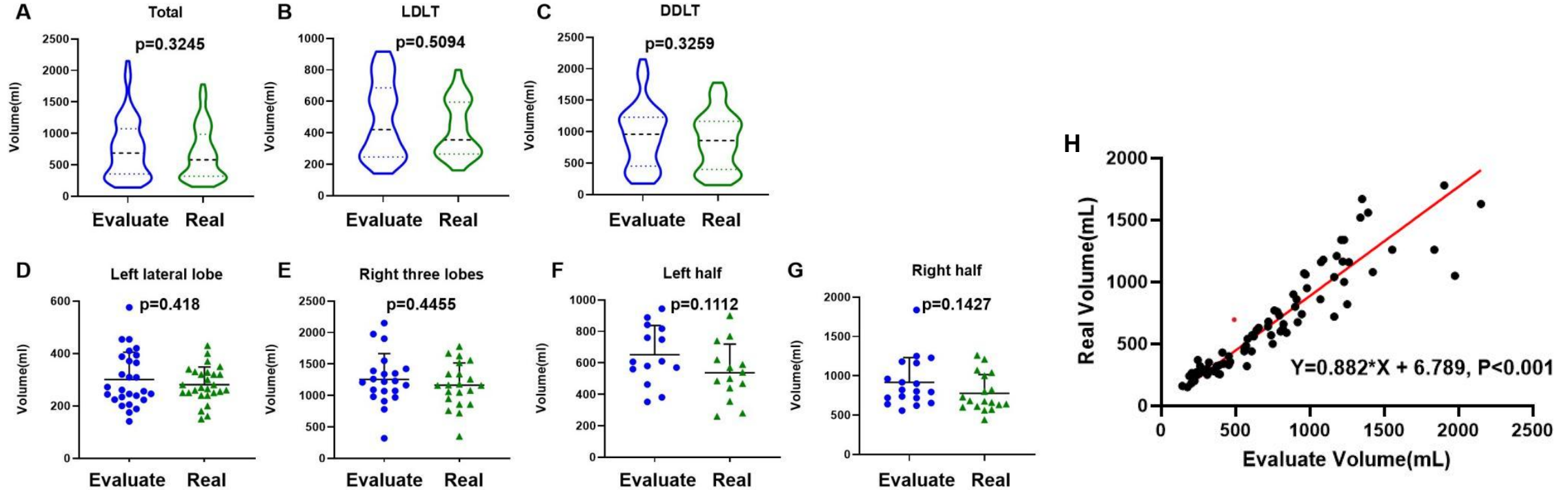

Figure 4. Comparison of evaluated and the real split donor liver volume. Comparison of the total donor volume between preoperative evaluated and real volume during the operation (A). Comparison of preoperative evaluated volume and real volume of LDLT (B). Comparison of preoperative evaluated volume and real volume of DDLT (C). Comparison of preoperative evaluated volume and real volume of left lateral lobe, right three lobes, left half and right half (D-G).Correlation analysis of the evaluate and real graft liver volume. A general linear model between the preoperative evaluate volume (X) and the real volume (Y) was established, yielding the equation Y = 0.882*X + 6.789, P < 0.001(H).

Application of Hisense CAS in Domino's liver transplantation and regeneration evaluation
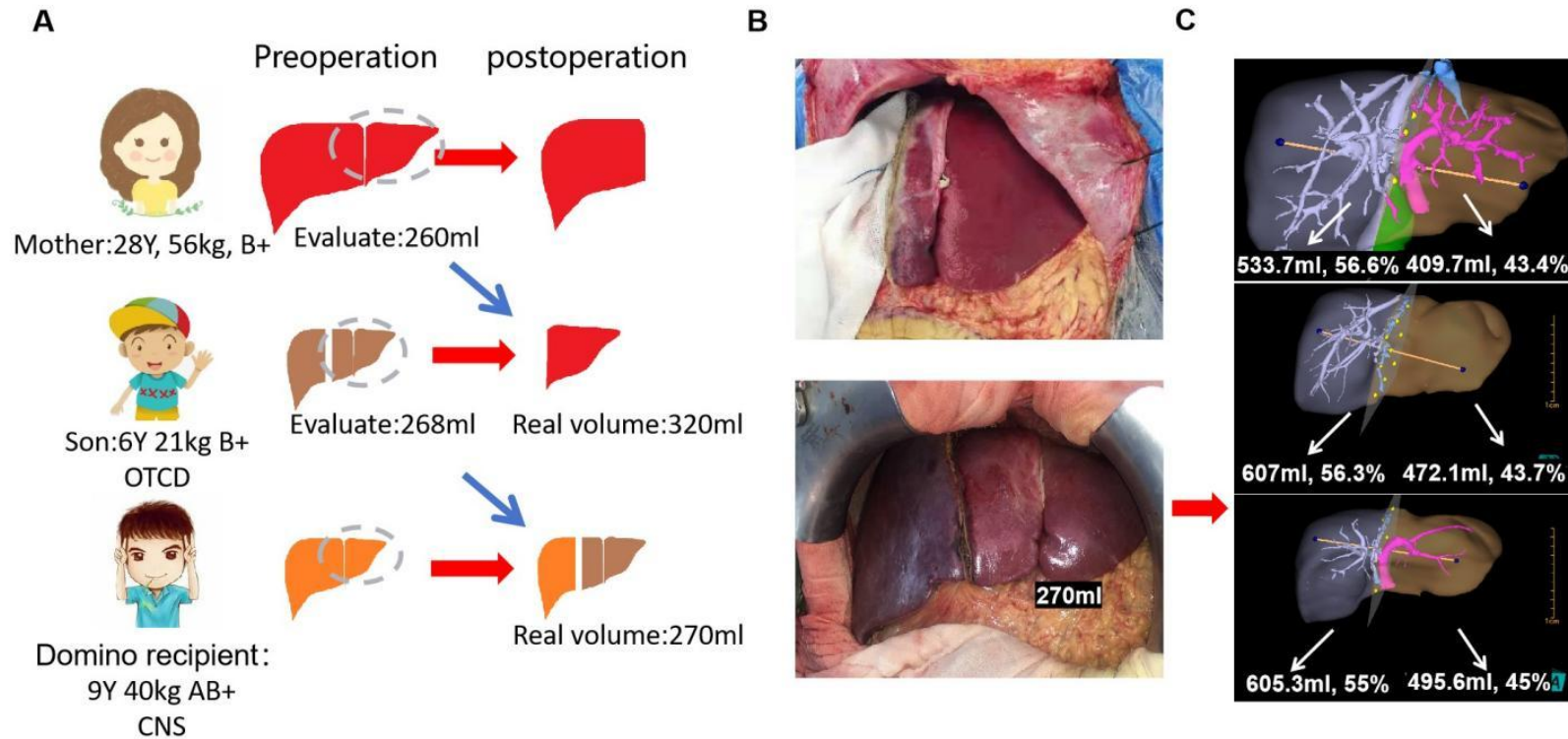

Figure 5. **Clinical use of Hisense CAS for a domino liver transplantation and split liver regeneration.** Graphical presentation of domino liver transplantation (A). Pictures after liver transplantation of the living and domino pediatric recipients (B). Use of Hisense CAS for liver regeneration after domino liver transplantation(C), upper is the volumes and percentages of the recipient's left and right half of liver before transplantation, middle is the recipient's left (from the first child) and right (the recipient's own) half of liver 1 month after transplantation, and lower is the recipient's left and right half of liver 2 month after transplantation.

Conclusion

Our results shown that the donor liver's volume may be precisely determined using Hisense CAS. There was no statistically significant discrepancy between the reconstructive assessment of the donor liver volume and the actual measured volume after surgery. Therefore, there is excellent therapeutic application value for Hisense CAS.