Original Article

Staged preoperative evaluation of potential living donors for liver transplantation

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Background: Living donor selection is crucial to minimize postoperative donor complications and to improve recipient outcomes. This study describes the selection process and evaluates the reasons for discarding potential donors in our living donor liver transplantation (LDLT) program.

Methods: Retrospective descriptive analysis from all potential donors evaluated in our LDLT program between April 2018 and July 2021. Selection criteria included age 18–60 years old, no significant medical or mental comorbidities, ABO and anatomical suitability.

Results: A total of 231 potential donors were evaluated. Mean age was 37.2±11.1 years and male gender in 51.9%. One hundred and one potential donors (43.7%) did not complete the evaluation, mainly because of availability of a deceased donor during the process (n=32; 13.9%), ABO incompatibility (n=14; 6.1%), progression or death of the recipient (n=20; 8.7%). Of the 130 who completed their radiological evaluation, 55 (42.3%) were anatomically unsuitable, mainly due to small liver remnant size (n=25/130; 19.2%) and steatosis (n=17/130; 13.1%). Out of the 231 potential donors, 75 were accepted as adequate donors (32.5%) and 36 candidates underwent liver donation (15.6%).

Conclusions: Only one-third of all potential donors are suitable for donation and half of them will undergo surgery. Given that in our setting computed tomography (CT) has a lower cost than magnetic resonance imaging (MRI), starting with a CT scan decreases the high cost of further workup of donors that are not anatomically suitable for living liver donation.

Keywords: Liver transplantation; living donor; donor hepatectomy; donor selection; living donor liver transplantation (LDLT)

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Introduction

Background

Low organ donation rate is a limiting factor in liver transplantation. The growing disproportion between the number of candidates listed for liver transplant and the availability of deceased organ donors is a problem in almost all countries, and the mortality on liver transplant waiting lists globally ranges from 5–25% (1,2). In this scenario, living donor liver transplantation (LDLT) has been developed to increase organ availability, achieving excellent donor and recipient outcomes. Currently, there are data from over 15,000 LDLT worldwide, demonstrating similar results to those obtained with deceased-donor graft (3-5).

Highlight box

Key findings

- At our center, 32.3% of potential donors were deemed suitable, which aligns with results from other high-volume centers. However, only 15.6% proceeded to liver donation, whereas this rate is nearly doubled in other studies. This discrepancy is attributed to the availability of deceased donors and the progression or mortality of recipients on the waiting list.
- The primary reasons for donor unsuitability were a small liver remnant and steatosis, and the anatomical findings in our population were similar to those reported globally.

What is known and what is new?

- Effective living donor selection is crucial to minimize postoperative complications and improve outcomes for recipients. Identifying the main reasons for discarding donor candidates helps optimize the use of time and resources in a living donor liver transplant (LDLT) program.
- This study provides insights into the selection process and preoperative evaluation outcomes for living donors at our hospital, in the first LDLT program in our country. We identified the main reasons for discarding potential donors and assessed key anatomical findings specific to our program.

What is the implication, and what should change now?

- Donor safety and the donor-recipient relationship should be the primary focus in living donor liver transplantation.
- Since donor evaluation is costly, we seek a more efficient and less expensive approach that maintains safety. In our series, 60.9% of potential donors who underwent computed tomography (CT) scans were considered suitable after a multidisciplinary review.
- Adopting a CT-first approach could improve selection efficiency by identifying anatomical issues early and preventing resource wastage on unnecessary evaluations. Consequently, we have updated our selection process to incorporate CT scans at the initial evaluation stage.

The LDLT technique has several advantages for the recipient: transplant can be performed electively before serious decompensation occurs in the recipient, complications associated with organ preservation are minimized, optimal quality of grafts are provided and it offers the possibility of liver replacement to selected patients who may be ineligible for deceased donor organ transplant (6). The main concerns with this type of liver donation are the potential risk of death or serious complications in the donor and the technical complications in the recipient. For this reason, selection of a suitable donor is crucial to minimize postoperative donor complications and to improve graft and patient survival for the recipient. The aim of donor evaluation is to determine whether or not the donor is medically and psychologically suitable for living donation (7-9).

During the evaluation of potential donors, only some of them will be eligible for living liver donation, due to ABO compatibility, liver anatomy and potential donor comorbidities. Additionally, during and/or after the donor evaluation process, the recipient may not become suitable for live donor liver transplantation due to disease progression, earlier availability of a deceased donor and liver transplantation, or waitlist mortality. As a result, only a small fraction of potential donors are able to ultimately undergo donor hepatectomy.

Rationale and knowledge gap

There are few studies in the literature evaluating the main reasons for discarding potential donors. In Latin America, as in many low and middle income health care systems, it is essential to understand the main reasons for donor unsuitability in order to make a more efficient use of time and resources in LDLT.

Objective

We conducted this study to describe the selection process and the outcomes of the preoperative evaluation of living donors, identifying the main reasons for discarding potential donors, and evaluating the main anatomical findings in liver donors evaluated in our program. We present this article in accordance with the STROBE reporting checklist (available at https://tgh.amegroups.com/article/view/10.21037/tgh-24-65/rc).

Methods

We conducted a retrospective study with data from our center at Pontificia Universidad Católica de Chile. All

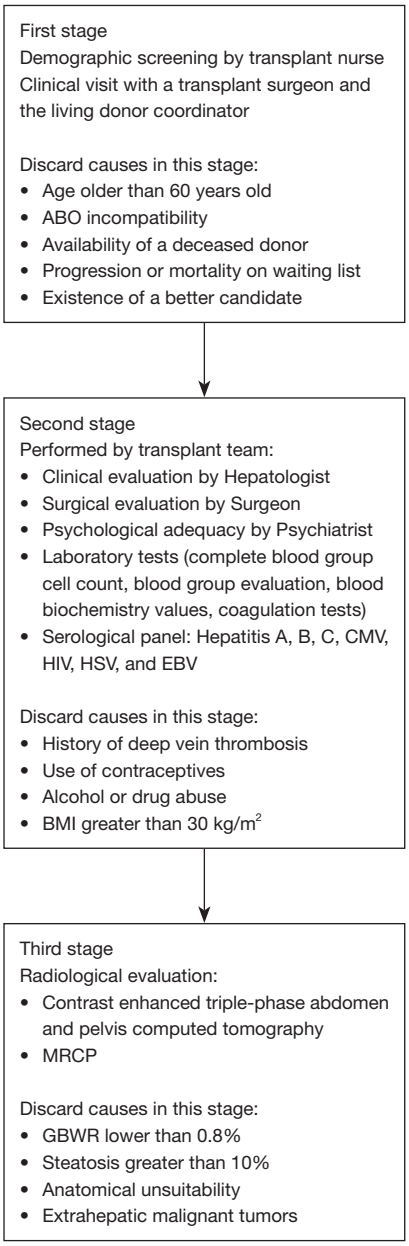

Figure 1 Initial flow chart of potential donor selection. This flowchart details the multi-stage process involved in selecting potential liver donors, beginning with demographic screening and progressing through clinical evaluations, psychological assessments, laboratory tests, and radiological evaluations. The figure is designed to provide a clear and comprehensive view of the rigorous selection process undertaken by the transplant team to ensure the safety and suitability of living donors. CMV, cytomegalovirus; HIV, human immunodeficiency virus; HSV, herpes simplex virus; EBV, epstein-barr virus; BMI, body mass index; MRCP, magnetic resonance cholangiopancreatography; GBWR, graft to body weight ratio.

potential donors evaluated in our adult-to-adult LDLT program between April 2018 and July 2021, were included. We focused on the adult liver transplant program and excluded donor evaluations for pediatric transplantation.

Selection process in our center

In our center, a step-by-step evaluation is performed to determine which potential donor should be excluded from the donation process. Below we describe the 3-stage selection process (*Figure 1*).

Our recipient selection criteria for living donor liver transplantation included all recipients that were considered for deceased donor liver transplantation, from 18–75 years old, for all Model for End-Stage Liver Disease (MELD) scores and including patients under a transplant oncology protocol beyond deceased donor listing criteria. Recipients for retransplantation and/or complex vascular anatomy evaluated by the surgical team, were not considered for living donor transplantation.

First stage

This stage is performed by our transplant nurse who makes a demographic screening to the potential donors. Donor must have a compatible blood type with the recipient, be younger than 60 years and older than 18 years and a consanguineous relative of the recipient up to the 4th degree or his/her spouse or partner. Living unrelated donors are considered if these are in-law related up to the 2nd degree since January 2021. All living donor candidates underwent a first clinical visit with a transplant surgeon and the living donor coordinator. This initial visit must guarantee the psychological adequacy of the donor and ensure the voluntary nature of the act of donation and that they truly understood the risk of the procedure. Likewise, the competence and autonomy of the donor between 18 and 25 years, must be evaluated. In this stage we included education on the availability of a deceased donor, progression or mortality of recipient on waiting list and existence of a better candidate for living donor as causes for discarding a donor candidate.

Second stage

Once the potential donor has passed the first stage and if he/she is eligible for donation, a complete clinical evaluation is carried out, with laboratory and serological tests. All potential donors must undergo a medical evaluation by a hepatologist, a psychiatrist and an independent physician outside the transplant team. A complete blood cell count,

blood biochemistry values, coagulation tests and viral serological panel [hepatitis A, B, C, cytomegalovirus (CMV), human immunodeficiency virus (HIV), Herpes Simplex Virus (HSV), Esptein-Barr virus (EBV)]. In patients with suspected heart disease, an echocardiogram is performed and if necessary, a stress echocardiogram. Exclusion criteria for living liver donors include history of deep vein thrombosis, use of contraceptives (waiting period of 2 months), alcohol or drug abuse, body mass index (BMI) greater than 30 kg/m^2, among other medical and/or psychological concerns.

Third stage

In the third stage, we performed a contrast enhanced triple-phase abdomen and pelvis computed tomography (CT) (Philips Brilliance with 64 channels; Philips Healthcare, Amsterdam, The Netherlands or General Electric Birghtspeed with 16 channels; General Electric Healthcare, Chicago, IL, USA), and a magnetic resonance cholangiopancreatography (MRCP) on all potential living donors (Siemens Magnetom Avanto; Siemens Medical Solutions, Erlangen, Germany), in order to assess the liver bilio-vascular anatomy and to perform a liver volumetric analysis of the potential liver graft. For the volumetric analysis, we used the software Intellispace portal V9 from Philips®. From the volumetric analysis, graft-to-recipient weight ratio (GRWR) is calculated, and the potential donors with a result lower than 0.8% are excluded from the donation in order to avoid the risk of small-for-size syndrome in the recipient. MRCP is also performed in all potential donors that reach this stage, to assess the biliary anatomy and the degree of steatosis in the potential liver graft. Potential donors with hepatic fat fraction less than 8% on magnetic resonance imaging (MRI) are deemed acceptable. When fat fraction is over 8%, a liver biopsy is required to demonstrate hepatic steatosis of less than 10%. Patients with 10–20% hepatic steatosis and/or BMI over 30 kg/m^2 are evaluated for potential weight loss and reassessment with MRI and biopsy. Thus, we minimize the need for a liver biopsy, only for patients with persistently high % fat fraction after weight loss, or donors that do not have the time to lose weight given recipient's severity, and the biopsy will clarify the exact level of steatosis.

Anatomical unsuitability is decided by the liver transplant surgeon team in a case-by-case discussion in our living donor multidisciplinary meeting. The development of a living donor program requires clinical judgement and initial strict selection of donors, that may be modified over time with more team experience and expertise. Absolute contraindications included a potential graft with 3 hepatic ducts or 2 hepatic arteries. The presence of 2 portal veins was considered unsuitable during the initial years, but has been accepted lately with reconstruction of both portal vein branches in the backtable. Accumulation of anatomical variations was also considered in this evaluation.

Statistical analysis

Medical records were reviewed, registering: sociodemographic data (age, gender, BMI and ABO blood group), radiological data (liver volumetry, anatomical variation of hepatic artery, bile duct, portal vein, focal liver lesions and extrahepatic malignant tumors, steatosis), and the reason for discard.

The data obtained was collected in a database in Microsoft Excel software. Qualitative variables are presented using absolute number and percentage. Numerical variables are presented using mean and standard deviation (SD).

Ethics

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Health Sciences Scientific Ethics Committee of Pontificia Universidad Católica de Chile (No. 240920001). Informed consent from participants was not required for this study due to the retrospective nature of the research.

Results

Demographic and clinical data

From April 2018 to July 2021, a total of 231 potential living liver donors underwent an evaluation in our center. The demographic and clinical data are summarized in *Table 1*. The mean age of patients was 37.2 years old (±11.1 years). One hundred and twenty (51.9%) patients were male. The mean BMI of the potential donors was 26.8 kg/m^2 (±3.5 kg/m^2). Most of them were son/daughter or siblings of the recipient [114 (49.4%) and 41 (17.7%), respectively]. The most frequent ABO blood group was O [n=166 (71.9%)], followed by group A [n=56; (24.2%)]. Most patients were Rh blood group positive [n=224; (96.9%)].

Causes for discarding

The causes for discarding potential donors are summarized

Table 1 Demographic characteristics (n=231)

Characteristics	Value
Age, years, mean ± SD	37.2±11.1
Male gender, n (%)	120 (51.9)
BMI, kg/m^2, mean ± SD	26.8±3.5
Relationship with the recipient, n (%)	
Son/daughter	114 (49.4)
Brother/sister	41 (17.7)
Husband/wife	18 (7.8)
Niece/nephew	13 (5.6)
Father/mother	12 (5.2)
Cousin	11 (4.8)
Uncle/aunt	7 (3.0)
Son in law	6 (2.6)
Grandchild	4 (1.7)
Partner	3 (1.3)
Brother-in-law	1 (0.45)
Son-in-law	1 (0.45)
Blood group, n (%)	
A	56 (24.2)
B	6 (2.6)
AB	3 (1.3)
O	166 (71.9)
Rh positive, n (%)	224 (96.9)

SD, standard deviation; BMI, body mass index.

Table 2 Causes for discarding potential donors on first or second stage

Causes	Discarded on first or second stage (n=101)	Total evaluated (n=231)
Availability of a deceased donor	32 (31.7%)	32 (13.9%)
Progression/mortality of recipient on waiting list	20 (19.8%)	20 (8.7%)
ABO incompatibility	14 (13.9%)	14 (6.1%)
Existence of a better candidate for living donor	10 (9.9%)	10 (4.3%)
Potential donor rejects donation	8 (7.9%)	8 (3.5%)
Comorbidities	7 (6.9%)	7 (3%)
Others	9 (8.9%)	9 (3.9%)

Table 3 Causes for discarding potential donors on third stage

Causes	Discarded on third stage (n=55)	Total evaluated with image (n=130)
Small liver remnant	25 (45.5%)	25 (19.2%)
Steatosis	17 (30.9%)	17 (13.1%)
Vascular anomaly	11 (20%)	11 (8.5%)
Extrahepatic malignant tumors	2 (3.6%)	2 (1.5%)

in *Tables 2,3*. Of the 231 donor candidates, 101 (43.7%) were discarded in the first stage and didn't complete the radiological evaluation. The main causes were the availability of a deceased donor [n=32/101; (31.7%)], drop-out due to disease progression or waitlist mortality of the recipient [n=20/101; (19.8%)], ABO incompatibility [n=14/101; (13.9%)] and the existence of a better candidate for living donation [n=10/101; (9.9%)]. In the third stage, 123 CT and 102 MRCP were performed. Of the 130 potential donors who underwent a CT and/or MRCP, the main causes of anatomical unsuitability were small liver remnant (SLR) [n=25/130; (19.2%)], steatosis [n=17/130; (13.1%)] and biliovascular unsuitability [n=11/130; (8.5%)]. Of all patients with steatosis on MRCP, only 2 donors required a biopsy after weight loss (no steatosis and 10% steatosis without fibrosis or periportal inflammation, respectively), and both underwent successful liver donation.

Of all 231 potential donors evaluated, 75 were accepted as suitable anatomical donors (32.5%), 71 were accepted after multidisciplinary evaluation (30.7%), and 36 candidates underwent liver donation (15.6%). The flow chart of the donor evaluation is synthetized in *Figure 2*.

Radiological evaluation

The findings in the radiological evaluation in the potential donors are summarized in *Tables 4-9*. Of the 130 patients who completed their radiological evaluation, 51 donor candidates had anatomic variation of the hepatic artery [n=51/130; (39.2%)]. The most frequent variations were: a replaced right hepatic artery (RHA) from superior mesenteric artery (SMA) or accessory RHA (type III or VI in Michels classification) [n=18/51; (35.3%)], a replaced

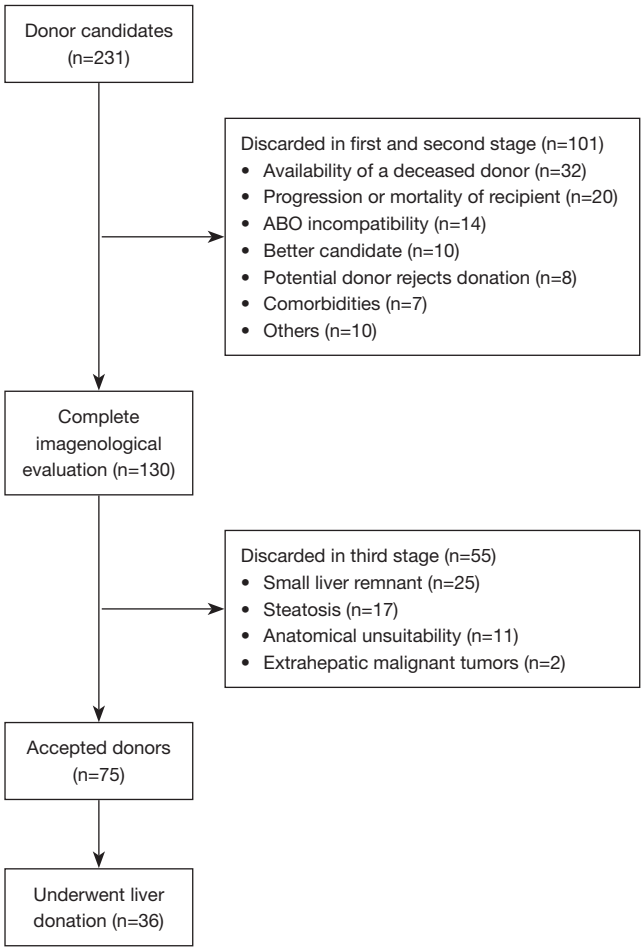

Figure 2 Flow chart of potential donor evaluation.

Table 4 Findings in radiological evaluation in potential donors

Parameters	Volumetric analysis (N=116)
Standard liver volume (mean ± SD), mL	1,446.4±303.6
Right liver volume (mean ± SD), mL	966.3±220.7
Left liver volume (mean ± SD), mL	467.3±105.4
Future liver remnant (mean ± SD), %	34.3±9.8
GRWR (mean ± SD), %	1.4±0.5

SD, standard deviation; GRWR, graft-to-recipient weight ratio.

Table 5 Hepatic artery variants from radiological evaluation in potential donors

Michels type	Total evaluated with image (n=130)	Variation (n=51, 39.2%)
III or VI	18 (13.8%)	18 (35.3%)
II or V	11 (8.5%)	11 (21.6%)
IX	7 (5.4%)	7 (13.7%)
IV	3 (2.3%)	3 (5.9%)
VII	2 (1.5%)	2 (3.9%)
VIII	1 (0.8%)	1 (1.9%)
Others	9 (6.9%)	9 (17.7%)

Table 6 Bile duct variants from radiological evaluation in potential donors

Type of bile duct	Performed MRCP (n=102)	Variation (n=29, 28.9%)
Right posterior duct into common hepatic duct	16 (15.7%)	16 (55.2%)
Right posterior duct into left hepatic duct	8 (7.8%)	8 (27.6%)
Accessory right posterior duct	2 (1.9%)	2 (6.85%)
Right posterior duct into cystic duct	2 (1.9%)	2 (6.85%)
Right anterior duct into common hepatic duct	1 (0.9%)	1 (3.5%)

MRCP, magnetic resonance cholangiopancreatography.

Table 7 Portal vein variants from radiological evaluation in potential donors

Type of portal vein	Total evaluated with image (n=130)	Variation (n=26, 20%)
Nakamura C	10 (7.7%)	10 (38.5%)
Nakamura B	5 (3.8%)	5 (19.2%)
Nakamura D	4 (3.1%)	4 (15.4%)
Nakamura E	4 (3.1%)	4 (15.4%)
Others	3(2.3%)	3 (11.5%)

left hepatic artery (LHA) from left gastric artery (LGA) or accessory LHA (type II or V in Michels classification) [n=11/51; (21.6%)] and a completely replaced common hepatic artery (CHA) from SMA (type IX in Michels classification) [n=7/51; (13.7%)].

Twenty-nine donors had anatomical variation of the bile ducts [n=29/102 who had MRCP; (28.9%)]. The most frequent variations were: drainage of the right posterior hepatic duct into common hepatic duct [n=16/29; (55.2%)], drainage of the right posterior hepatic duct into the left

Table 8 Focal liver lesions from radiological evaluation in potential donors

Type	N (%)
Total	11/130 (8.5)
Hemangioma	5 (45.5)
Focal nodular hyperplasia	3 (27.3)
Simple cyst	2 (18.2)
Granuloma	1 (9.1)

Table 9 Extrahepatic malignant tumors from radiological evaluation in potential donors

Type	N (%)
Total	2/130 (1.54)
Intestinal GIST	1 (50)
Renal cell carcinoma	1 (50)

GIST, gastrointestinal stromal tumor.

hepatic duct [n=8/29; (27.6%)].

Twenty-six donor candidates had anatomic variation of the portal vein [n=26/130; (20%)]. The most frequent variation was to have two independent right portal veins, as an extraparenchymal branching of the right anterior portal vein from the left portal vein (type C in Nakamura classification) [n=10/26; (38.5%)], followed by trifurcation of the portal vein (type B in Nakamura classification) [n=5/26; (19.2%)], intraparenchymal branching of the right anterior portal vein from the left portal vein (type D in Nakamura classification) [n=4/26; (15.4%)] and undivided main portal trunk (type E in Nakamura classification) [n=4/26; (15.4%)].

Eleven potential donors had focal liver lesions [n=11/130; (8.5%)], being hemangioma [n=5/11; (45.5%)] and focal nodular hyperplasia [n=3/11; (27.3%)] the most frequent. Extrahepatic malignant tumors were identified in 2 patients, and the final diagnosis were intestinal gastrointestinal stromal tumor (GIST) and a renal cell carcinoma. Of the 130 patients who completed their radiological evaluation, 116 performed a liver volumetry. The mean standard liver volume was 1,446.36 mL (±303.59 mL). The mean right and left liver volume were 966.3 mL (±220.7 mL) and 467.3 mL (±105.4 mL), respectively. The mean future liver remnant was 34.3% (±9.8%) and the mean GRWR was 1.4% (0.5%).

Out of the 130 patients that completed the third stage and had complete radiological evaluation, 55 (42.3%) were discarded due to radiological findings including small liver remnant (n=25, 45.5%), liver steatosis (n=17, 30.9%), vascular anomaly (n=11, 20%) and extrahepatic malignant tumor (n=2, 3.6%) (*Table 3*). Only 75 patients were considered adequate donors radiologically and 36 of them underwent donation.

CT performance

Of the 123 potential donors who underwent a CT, 75 were adequate anatomical donors (60.9%). A total of 96% of donors with adequate anatomy on CT were deemed adequate donor candidates after evaluation.

Discussion

Living donor selection is essential to minimize postoperative donor complications and to improve recipient outcomes, and knowing the main reasons for discarding donor candidates is important in order to make more efficient the use of time and resources in a LDLT program. In the observational study conducted by Dirican *et al.* in 2015, they found that 31% of the potential donors were accepted as suitable for donation (9). In a similar way, Karakaya *et al.* in 2020, reported 32.3% of donor candidates as suitable for donation over 1,387 patients (10). This is similar compared with the 32.4% of potential donors, accepted as adequate donors in our study. In the study performed by Dirican *et al.*, 29% of the potential donors underwent donation, meanwhile in our study, we found that just 15.6% finally underwent liver donation. The cause of this could be that only 2% of their potential donors were discarded due the availability of a deceased donor and 0.9% due progression or mortality of the recipient in the waiting list, meanwhile in our study we found that 13.9% (n=32/231) and 8.7% (n=20/231) were discarded for these reasons, respectively. In their study, the main causes for unsuitability for liver donation were small liver remnant in 43% and steatosis in 38.4%. This is similar compared with our findings (45.5% and 30.9%, respectively) (9).

The BMI is an important factor in the selection of an appropriate living donor, the degree of hepatic steatosis is a major concern. In living liver donors with hepatic steatosis, macrovesicular fat level ≥30% are thought to increase the risk of poor graft function or decreased graft survival. Higher fat levels also affect donor safety. Therefore, assessment of BMI

in the first step of potential liver donor evaluation should be emphasized. In our series the mean BMI of the potential donors was 26.8 kg/m^2 (±3.5 kg/m^2) (11,12).

The CT provides valuable information that will be useful in choosing the most suitable candidate and in identifying anatomic variants that may alter the surgical approach or exclude the potential donor. The anatomic variants of the hepatic artery are common and present in approximately 42% to 55% of cases, and the most frequent are: a replaced or accessory RHA arising from the SMA (type III and VI) and a replaced or accessory LHA arising from the LGA (type II and V) with 33% and 35% of the cases with anatomical variant, respectively (13-15). In a recent study conducted by Imam *et al.* in 2021, they analyzed the anatomic variant of the hepatic artery of 210 potential donors and found variants in 30% of the potential donors being type III or VI and type II or V the most frequent, representing the 30% and the 52.8% of the cases with anatomical variant, respectively (16). In a similar study conducted in 2020 with 610 potential donors, Yan *et al.* determined that type III or VI and type II or V represents only 13% and 32% of the patients with anatomical variants of the hepatic artery (17). In our study, we found type III or VI were the most frequent variant of the hepatic artery (35.3%) followed by type II or V (21.6%).

The anatomical variations of the portal vein appear in approximately 10% of cases. Covey *et al*. in 2004 retrospectively reviewed 216 CT in a single institution and they found a 35% variation of the portal vein (18). In a large series of 1,384 patients reviewed by Koc *et al.* in 2007, the portal vein variation was reported to be 21.5% (19). In 2021 Katsourakis *et al.* conducted a systematic review with 3,715 patients included. In their analysis, the percentage of portal vein variation was 25%. In our series, 20% of the donor candidates had anatomical variation of the portal vein, which is similar to those reported in the literature (20). In the Nakamura classification, trifurcation of the portal vein (type B) and extraparenchymal branching of the anterior branch from the left portal vein (type C) presents in approximately 2.5% of the cases, each. The intraparenchymal branching of the anterior branch from the left portal vein (type D) presents in approximately 1.7% of the cases. An undivided main portal trunk represents 0.8% of the cases (21). In the study of Katsourakis *et al.*, trifurcation of the portal vein (type B) represents 46% of the anatomic variation of the portal vein and the branching of the anterior branch from the left portal vein (type C and D) represents 39.5% of the anatomic variations. In our study, the most frequent finding was an extraparenchymal branching of the anterior branch from the left portal vein (type C) (38.5%), followed by trifurcation of the portal vein (type B) (19.2%) and intraparenchymal branching of the anterior branch from left portal vein (type D) (15.4%) (20).

Anatomical variations of bile ducts are common and important to highlight before LDLT. Anomalous biliary tract anatomy is present in 40% of the population and unanticipated biliary variations may be a source of post-transplant complications such as biliary leakage, strictures, and graft failure. Prior knowledge and timely planning improve the outcomes (14,22). The variation includes: trifurcation (20.8% to 49% of the anatomic variation of the bile duct), the right posterior duct draining into the left hepatic duct (14% to 61.7% of the anatomic variation of the bile duct), the right posterior duct draining into the common hepatic duct (1.4% to 20.3% of the anatomic variation of the bile duct); and the right posterior duct draining into the cystic duct (1.8% to 3.3% of the anatomic variation of the bile duct) (23-27). In our study, we found 22.3% of the donor candidates had anatomic variation of the bile ducts and the most frequent were: drainage of the right posterior hepatic duct into common hepatic duct (55.2%), drainage of the right posterior hepatic duct into left hepatic duct (27.6%).

During the evaluation of potential donors, unexpected findings can be reached, and these could be in some cases very relevant for the patient. The finding of an unexpected malignant tumor in the preoperative evaluation of a potential living donor is a rare scenario, but in a high-volume transplant center, it will happen. In our study, we found 2 extrahepatic malignant tumors in the evaluation of donor candidates, 1 renal cell carcinoma and 1 intestinal GIST. In the observational study conducted by Karakaya *et al.* in 2020, they found 6 extrahepatic malignant tumors over 1,387 donor candidates (2 pancreas adenocarcinoma, 1 ovarian carcinoma, 1 renal cell carcinoma, 1 thyroid papillary carcinoma and 1 osteosarcoma) (10).

An increasing body of literature of living donors demonstrated the potential financial impact on the donor's social relationships due to the donor using personal/family savings or retirement funds. Since donor evaluation is an expensive process that must be afforded by the patient and their family, in our center we are looking for a more efficient, less expensive and equally safe formula this evaluation (28-31). In our series, we found that 60.9% of the potential donors that underwent a CT were finally considered as accepted donors on multidisciplinary evaluation. We consider that a CT-first approach in the

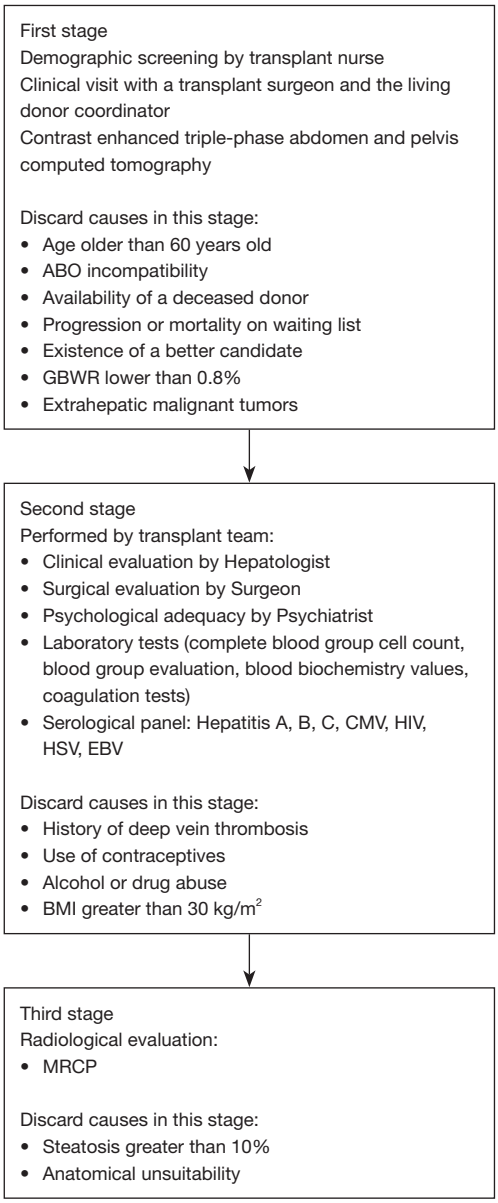

Figure 3 Modified flow chart of potential donor selection: "CT-First Approach". CT, computed tomography; GBWR, graft to body weight ratio; CMV, cytomegalovirus; HIV, human immunodeficiency virus; HSV, herpes simplex virus; EBV, epstein-barr virus; BMI, body mass index; MRCP, magnetic resonance cholangiopancreatography.

potential living donor evaluation could be a more efficient selection process, because it would identify anatomical factors that precludes the transplantation in a first stage of the evaluation and the patient shouldn't spend more resources in complete a futile process. After this study we have modified our algorithm and flow chart of the selection process, to include the CT in the first stage of our evaluations (*Figure 3*). This avoids the high costs of laboratory tests and subspecialty evaluation on the 39.1% of patients that are not anatomically suitable for donation.

Conclusions

Almost half of the potential donors didn't complete the evaluation because of progression, death or deceased donor transplantation of the recipient. Steatosis, SRLS and anatomical variation are the main causes of dropout. Only 1/3 of potential donors are suitable for donation and half of them will undergo surgery. It is important to know the main exclusion criteria met by potential donors, in order to make a more efficient use of time and financial resources. CT-first approach decreases the high cost of laboratory tests and evaluations on 40% of patients who are not anatomically suitable for living liver donation. Out of all anatomically suitable donors on CT-scan, 96% of them will be approved after complete donor evaluation. Considering that, the CT-first approach seems to be a more efficient selection process, and we strongly suggest further research to validate this approach.

Although the rate of discarding living donors is quite high, the implementation of this program, the only LDLT program in our setting, has successfully positioned itself as a viable alternative to increase the availability of liver grafts, offering this alternative to every recipient in the country, covering their costs with the public health insurance.

The low rate of potential living liver donors who ultimately donated seems to be due to both strict guidelines and the simultaneous presence of a robust cadaveric program. Emphasizing that the availability of a deceased donor was 32/231 (13.9%).

It is also important to highlight that, since it is an initial program, our selection criteria were stricter at the beginning. However, as we gained more expertise, these criteria were progressively broadened, allowing the acceptance of more donors.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Health Sciences Scientific Ethics Committee of Pontificia Universidad Católica de Chile (No. 240920001). Informed consent from participants was not required for this study due to the retrospective nature of the research.

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