Received: 13 March 2023 | Revised: 22 March 2023 | Accepted: 13 April 2023

DOI: 10.1111/petr.14536

CASE REPORT

WILEY

Hyperreduced left lateral living donor liver transplant in a 4.5 kg child—A first in Africa

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Abstract

Background: Supply–demand mismatch in solid organ transplantation is particularly pronounced in small children. For liver transplantation, advanced surgical techniques for reducing deceased and living donor grafts allow access to life-saving transplantation. Living donor left lateral segment liver grafts have been successfully transplanted in small children in our center since 2013, the only program providing this service in Sub-Saharan Africa. This type of partial graft remains too large for children below 6 kg body weight and generally requires reduction.

Methods: A left lateral segment graft was reduced in situ from a directed, altruistic living donor to yield a hyperreduced left lateral segment graft.

Results: The donor was discharged after 6 days without complications. The recipient suffered no technical surgical complications except for an infected cut-surface biloma and biliary anastomotic stricture and remains well 9 months post-transplant.

Conclusions: We report the first known case in Africa of a hyperreduced left lateral segment, ABO incompatible, living donor liver transplant in a 4,5 kg child with pediatric acute liver failure (PALF).

KEYWORDS
ABO incompatibility, acute liver failure, hyperreduced liver graft, living donor liver transplantation

1 | INTRODUCTION

Liver transplantation is the gold-standard treatment in both acute and chronic liver failure. The need for organs has always outpaced the supply, particularly in children, where access to size-matched deceased donor organs is severely restricted. Several surgical advances have expanded the organ pool, including reduced and split deceased and living donor liver transplantation.[1] A particular challenge in pediatric liver transplantation remains appropriate graft size matching to the recipient.

The ideal graft-to-recipient weight ratio (GRWR) in children requiring liver transplantation is 2–4. In addition, the ratio between the recipient's anterior–posterior diameter of the abdominal wall at the level of the first lumbar vertebrae, and the maximal graft thickness should be <1.[2] Above a GRWR of 4, recipients are at significant risk of the large-for-size syndrome, which is associated with inadequate

Abbreviations: CT, computerised tomography; GRWR, graft to recipient weight ratio; HLH, hemophagocytic lymphohistiocytosis; HTK, histidine-tryphtophan-ketogluterate solution; HVPG, hepatic venous portal gradient; ICU, intensive care unit; INR, international normalised ratio; PALF, pediatric acute liver failure; PCR, polymerase chain reaction.

graft perfusion, vascular complications, and intra-abdominal compartment syndrome upon primary closure of the abdominal cavity.[3]

A left lateral segment liver graft, comprising Couinaud's segments II and III, supplies on average 244 ± 44 g of liver graft, which in a child weighing less than 6 kg in body weight, will comprise a GRWR >4%.[4] As such, these grafts require further reduction in volume into a monosegment graft or a hyper-reduced left lateral segment graft.[5] We report the first hyperreduced left lateral segment liver transplant performed in Africa.

2 | CASE REPORT

An ex-prem male twin, at a corrected age of 3 weeks and weighing 4.5 kg, was referred to our center in Johannesburg, South Africa. The child presented with features of acute liver failure after a brief history of a viral-type illness dominated by gastrointestinal symptoms. After admission to the Transplant Intensive Care Unit (ICU), the child's condition rapidly deteriorated, meeting King's College criteria for transplantation based on the presence of grade IV encephalopathy, severe coagulopathy (INR exceeding 10), and hyperbilirubinemia (serum bilirubin 370.6 μmmol/L). Additional laboratory results included an ammonia level of 123 μmol/L with a Factor V level of <5%. Hemophagocytic lymphohistiocytosis (HLH) as a cause of liver failure was initially suspected based on high ferritin levels at 214 714 μg/L and bicytopenia, but was subsequently excluded based on the bone marrow biopsy results. No other medical contraindications to transplantation were identified on standard work-up. A positive result for Enterovirus/Rhinovirus on a multiplex PCR respiratory swab was the only pathogen isolated from the patient. There was no history of paracetamol overdose or exposure to toxins. His twin sister remained well.

The patient was listed as a Status 1A recipient, but no suitable deceased donors became available. Potential living donors were assessed, and both parents were found to be unsuitable. An altruistic donor, a family friend, fulfilled the criteria for living donation and consented. The donor was a 36-year-old female who weighed 58 kg and had no relevant medical history. CT volumetry calculated a 289 g left lateral segment graft, which amounted to a GRWR of 6.4%. In-situ hyperreduction of the left lateral segment graft was planned. Of note, the donor was blood group A, and the recipient was blood group O with anti-A iso-agglutinin titers pre-transplant measured at 1:4. Due to the expected age-based immunological naivete of the recipient, ABO incompatibility was not an expected complicating factor.

2.1 | Donor surgery

A midline abdominal incision was used to gain access to the abdominal cavity and no contra-indications to donation were found. The left lateral segment procurement commenced as previously described with a hilar dissection.[6] First, the left hepatic artery was dissected from its origin to the umbilical fissure. Next, the left portal vein was dissected free at the level of the portal vein bifurcation. Standard use of intra-operative ultrasound allowed mapping of the middle hepatic vein, allowing for a transection line 5 mm to the right of the falciform ligament with the left hepatic vein finally identified and isolated. Transection of the left hepatic duct was guided by routine intra-operative cholangiography. Parenchymal dissection was achieved using an ultrasonic aspiration device.

Prior to vascular clamping and transection, the graft was modified into a hyperreduced left lateral segment as previously described.[7] Whilst segment III parenchyma was resected from the graft, dissection around the segment III pedicle was avoided. The graft was further hyper-reduced with transection of the lateral edge using the same device and excess tissue was discarded. The plane of reduction followed the anatomical variation of the segment 3 portal venous drainage. Following this reduction, the graft vessels were transected, and the graft was perfused with a histidine-tryptophan-ketoglutarate (HTK) solution. The procured liver graft weighed 160 g and amounted to a GRWR of 3.5%.

2.2 | Recipient surgery

The standard bilateral subcostal incision was performed and upon exploration of the abdominal cavity, no contra-indications to transplantation were identified.

A vena cava-preserving total hepatectomy followed, and a native liver weight of 69 g was recorded. The procured graft was implanted using the standard technique during left lateral segment liver transplantation.[8] Graft hepatic vein venoplasty was performed on the back-table. The recipient right, middle, and left hepatic veins were united into a single orifice and this opening was anastomosed end-to-end to the graft left hepatic vein. The portal vein was reconstructed between the recipient right and left portal vein branch patch and the graft left portal vein. Hepatic artery reconstruction

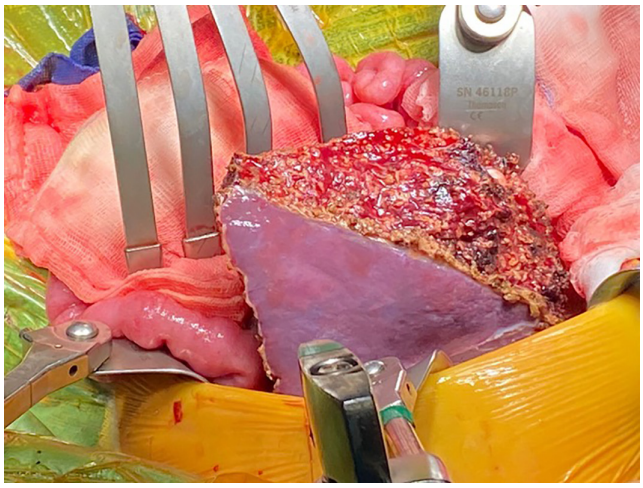

FIGURE 1 Hyperreduced left lateral segment graft living donor liver transplant post-reperfusion.

was performed using micro-surgery techniques.[5] Cold ischemic time amounted to 50 min with the warm ischemic time of 20 min. Biliary continuity was established using a Roux-en-Y hepato-enterostomy to a single left hepatic duct. Primary abdominal closure was achieved with no alteration in respiratory pressures. Intra- and post-operative Doppler assessment revealed excellent graft vascular inflow and outflow. Total operative time was 5 h 30 min (Figure 1).

2.3 | Post-operative course

The donor was discharged from hospital on day 6 after an uncomplicated stay. The recipient recovered in intensive care and was extubated on day 7. Sepsis was diagnosed on day 13 post-transplant, and an infected intra-abdominal collection was percutaneously aspirated and drained. The patient developed graft dysfunction with evidence of mildly dilated ducts on imaging 4 months post-transplant. A percutaneous trans-hepatic biliary drain was placed, and an anastomotic stricture was dilated over 3 sessions. Doppler assessment of inflow and outflow revealed no vascular issues with the graft. Anti-A isoagglutinin titers remained low at 1:16 and no hemolysis was diagnosed. Persistent graft dysfunction prompted a liver biopsy 8 months post-liver transplant which revealed sinusoidal congestion with early fibrosis, with no evidence of antibody-mediated rejection. Features of T-cell mediated rejection were identified at a Banff score of 7/9. Modest improvement in graft function followed a 3-day steroid pulse. Venous outflow obstruction was excluded on directed venography. Hepatic vein portal gradient (HVPG) at this time measured at 14 mmHg. The portal vein has remained patent and measured high pressures at 22 mmHg. Splenic artery embolization was performed for refractory pancytopenia in the face of a normocellular bone marrow aspirate.

A presumptive diagnosis of Tacrolimus-induced sinusoidal congestion was made, and the child was converted to an Everolimus-based immunosuppression regimen. His graft function has improved, however, failure to thrive has been a persistent concern and at the time of publication no gastrointestinal cause for this could be found.

3 | DISCUSSION

The utilization of hyper-reduced liver grafts has been made possible by stepwise innovation in surgical technique starting with Houssin et al. describing transplantation of an isolated segment III liver graft from a deceased donor.[9] In this case, a left lateral segment graft was reduced post-reperfusion to allow for primary closure of the abdomen. Difficulty in obtaining hemostasis during the transection of a freshly transplanted liver graft complicated this procedure.

Strong et al. described ex-vivo reduction of a left lateral segment deceased donor graft leaving a segment III monosegment graft,[10] and Mentha et al. subsequently published a case of ex vivo reduction to a segment II graft.[11] The first case of in-situ reduction of a left lateral segment graft to produce a segment II graft in a living donor was published by Santibañes et al.[7] In situ resection of segment III necessitates a hazardous dissection in the portal plate which may lead to pedicle injuries to the graft. In-situ reduction in a living donor to produce a monosegment III graft avoids this potential complication and was described by Enne et al.,[1] however, this type of reduction may not lead to an adequately reduced graft, and further mono-segment reduction has been described and employed by Kasahara et al.[8]

A relatively safe form of reduction of a left lateral segment deceased donor graft has also been described by Attia et al. in which the graft is reduced in its caudal and lateral aspect, leaving behind portions of both segments II and III.[12] This technique voids unnecessary hilar dissection of the graft and significantly reduces graft volume. A similar hyper-reduction was described in the living donor by Kasahara et al.[8] Our team elected to perform an in-situ hyperreduction of a left lateral segment graft without transecting the segment III pedicle, and in order to achieve a GRWR <4%, further reduced the lateral aspect of the graft.

As far as can be determined, this case report is the first of its kind in Africa. Both the recipient and the donor had an uneventful peri-operative course. Despite post-transplant challenges in the recipient, this is a critical landmark in pediatric liver transplantation on the continent. Refining and employing the hyper-reduced living donor liver transplantation technique offers a lifeline to small children needing liver transplantation.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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How to cite this article: Van der Schyff F, Britz RS, Strobele B, et al. Hyperreduced left lateral living donor liver transplant in a 4.5 kg child—A first in Africa. *Pediatric Transplantation*. 2023;00:e14536. doi:10.1111/petr.14536