

ASTS DCD Liver Task Force DCD Liver Transplant Guidelines

The following suggestions represent the collective opinions of the faculty for the ASTS DCD Liver Workshop as informed by a national survey of liver transplant surgeons and recent published literature. They are designed to reflect general principles and not determine specific clinical practice.

Donor Selection:

- Donor age < 60 y.o. Highly selected livers from 60-65 y.o. donors can be considered provided cold and warm ischemic times are low.
- Donor BMI < 35. Highly selected livers from donors with BMI 35-40, normal pre-operative imaging, and acceptable biopsy from post-mortem biopsy may be considered.
- There are no specific surgical or medical contraindications to DCD liver donation beyond standard exclusions for all donors. Diabetes has been shown to be an independent risk factor on multivariate analysis in DCD donors > age 50, but this is not demonstrated in the general DCD liver population.
- Donors with extensive prior abdominal surgery may make rapid organ recovery challenging.
- The use of tools to predict death is insufficiently precise to exclude consideration of donors.
- Travel time, distance, and other logistics should be considered to enable goal cold ischemic time < 6 hours.
- Use caution in accepting donors with AST/ALT that remain > 500 at the time of recovery or continue to trend up.
- Macrosteatosis on biopsy should be < 30%
- Cautiously consider DCD livers declined intraoperatively by other centers. Understand the reasons why organ declined (i.e. recipient issues vs. donor issues). Review the DCD recovery flowsheet in detail. Prefer accepting re-allocated livers for in-house patients to limit cold ischemia time.

Recipient Selection:

- Consider patients with a low likelihood of organ offer with non-DCD organ including patients with symptoms of portal hypertension and low MELD scores, progressing HCC, refractory pruritus, and non-standard OLT indications.
- Avoid re-transplants
- Calculated MELD < 35 given likelihood of standard organ offer with SHARE 35. Selected patients with MELD > 35 can be considered with ideal DCD livers (Age < 50 and CIT < 6 hours).
- Avoid recipients with extensive prior upper abdominal surgery (e.g. prior hepatectomy, open cholecystectomy, open gastric surgery). Routine laparoscopic cholecystectomy or colon surgery should not preclude DCD liver transplant.
- Avoid DCD in Pediatric transplants unless patient is at risk of death prior to DBD.
- Cautiously consider DCD for liver/kidney transplant. Use of DCD donors with low KDPI may be acceptable. Kidney cold perfusion is preferred compared to static perfusion (ice).

Recovery Logistics:

- An experienced procurement surgeon is critical for the expeditious flushing and removal of DCD donor livers without organ or vascular injury or prolonged donor warm ischemia time. In general, an attending surgeon or senior transplant fellow from the transplant center or an experienced recovery surgeon from the OPO is preferred.
- DCD liver recovery for other centers requires direct communication and clear understanding of time limits

- Perform pre-recovery huddle with OPO and OR personnel is mandatory.
- Withdrawal of life-sustaining treatments (WLST) in OR or in holding area next to OR with a maximum of 3 minutes travel time to OR is strongly preferred. Avoid travel between floors, recognizing that location of WLST is at the discretion of the donor hospital and/or OPO.
- Surgical team should not be in OR while the donor is in the OR until after declaration of circulatory death (in case of withdrawal of support in the OR). Room set-up, including surgeon Mayo stand set-up, should occur prior to donor entry into the OR. Surgical teams should be permitted to enter during the observation period to prepare for incision at the end of the observation period.
- Prep and drape prior to withdrawal of support when allowed by OPO/hospital policy. This can be performed in holding area and the patient covered with sterile drapes.
- Heparin administered prior to withdrawal of support unless specific hospital policy precluding administration, mandatory once BP < 80.
- Limit functional donor warm ischemia time with SBP < 80 or sat < 80 to organ flush of 30 minutes (80/80 rule)
- Declaration of death should be based upon cessation of circulation using arterial line tracing and not electrical activity. This should be reviewed with the declaring physician by OPO personnel. The surgical team can NOT make recommendations about any aspect of the end-of-life process, including how circulatory death is declared.
- Observation period should be maximum 5 min, or less according to OPO and donor hospital policy.
- Time from incision to cannulation/flush < 4 min
- Warm ischemic time declaration to aortic flush < 10 minutes including observation period
- Minimum 3 L aortic flush. Prefer use of pressure bags to overcome vascular resistance.
- In situ portal cannulation is optional.
- Routine retrograde back table flush (200-500 cc per hepatic vein) and portal flush (2 liters or until clear)
- In situ flush of bile duct and gallbladder and repeat flushing of both on back table. Goal flush to liver explant of < 15 minutes. Maximal time to organ retrieval after flush is 30 minutes. In the case of liver/lung recovery this criteria should be discussed with the lung recovery team during the huddle.
- Post recovery biopsy criteria (BMI > 30, Hep C, Hep B, appearance of liver after flush, extensive alcohol use)
- OPO compensation for standby time in the case of donors that do not progress to circulatory death
- Vitals no less than q 2 minutes after extubation recorded on DCD flowsheet and uploaded into DonorNet

Transplant Logistics:

- Recipient should be in-house and prepared for surgery with operating room on standby prior to withdrawal of care
- A second surgical team should begin the recipient procedure prior to organ arrival
- It is critical to keep CIT < 6 hours
- Rapid recipient hepatectomy to avoid prolonged cold ischemic time.
- Minimization of recipient warm ischemia time is critical. Restore arterial inflow as soon as possible for blood supply to bile ducts, facilitated by arterial preparation prior to removing donor organ from ice.

Need further investigation/research

- Use of TPA or other intraoperative medication
- Benefit/role for machine perfusion

- Preservation solution: HTK vs. UW
- Benefit of simultaneous arterial/portal reperfusion vs. sequential
- Blood flush vs. colloid flush
- Use of Thymoglobulin as induction (4.5 mg/kg)

Example Recovery Procedure Details

These steps detail one method of DCD liver recovery. Some steps may be modified to accommodate surgeon experience and comfort level with specific maneuvers.

1. Pre-Recovery

a. Team assembly

- i. Two experienced surgeons preferred

b. Communication

i. Pre-departure to donor hospital

1. Discuss logistics with OPO and confirm that a pre-withdrawal huddle will take place, there is a plan for heparin administration, and that there are no unreported surgical obstacles (previous sternotomy, ostomy bag in place, etc.)

ii. Pre-Withdrawal Huddle at Donor Hospital

1. Must be remote from the patient
2. Parties Involved with Huddle:
 - a. OPO staff (leads the huddle)
 - b. Hospital nursing staff
 - c. Hospital OR staff
 - d. Withdrawal of support/declaring physician and team
 - e. Recovery surgical team
3. At this huddle, the following are discussed:
 - a. Review authorization form, ABO, etc. and sign appropriate forms
 - b. Full discussion/explanation of everyone's role by the OPO
 - c. Review any other considerations such as donor-specific issues, confirm hair removal and EKG leads moved to back, etc.
 - d. Confirm that heparin will be administered according to hospital/OPO policy
 - e. Review the transfer process to OR after declaration of circulatory death in excruciating detail in cases where withdrawal is not in the operating room

c. OR Setup

- i. In cases where withdrawal of support is outside of operating room, take personal responsibility for ensuring a smooth transfer by removing obstructions
 1. Moving anesthesia machine, bovie, and other unnecessary equipment away from OR table
 2. Keep sterile equipment away from possible contamination during the patient transfer
 3. Ensuring that the path to the OR is clear of obstructions

- ii. Set up dedicated Mayo stand with all items needed for the incision-to-cannulation portion of the procedure
 1. Scalpel
 2. Curved Mayo Scissors
 3. Abdominal retractor
 4. Lap pads/towels
 5. Pick-ups and Long Scissors
 6. Right-angle
 7. Two large (prefer #2) silk ties, umbilical tapes, or “bag ties” pre-loaded on passers for securing the aortic cannula (one primary, one backup)
 8. Prep sticks x 2 and Drape (prefer the ones with the pockets)
 - a. This set-up takes the (often inexperienced) scrub tech out of the equation for the critical incision-to-cannulation time
- iii. Discussion with Scrub Tech:
 1. Priority #1: Pass off cannula (to OPO staff)
 2. Priority #2: Pass off suction (to OR circulator)
 - a. One Yankauer
 - b. One Poole Suction
 3. Priority #3: Set up sternal saw

2. Flush

- a. Flush 3-5 liters of UW in aorta, in-situ portal flush optional
- b. Prefer an actual large-bore cannula rather than the white-tip cannula at the end of the flush tubing (can be hard to get into the aorta in certain cases)
- c. Keep UW on ice until confirmed that donor is rolling into OR
3. Recovery Procedure with Rapid Extraction without Portal Dissection (super-rapid technique)
 - a. Call recipient surgeon to ensure that recipient is ready and recipient OR is set-up
 - b. Only give heparin after confirmation that donor OR is ready to go.
 - c. First several minutes
 - i. Enter the OR at the end of the 5-min observation period. Keep prep-sticks in hand and crack/shake them as you walk into the OR in cases where the patient is not already prepped/draped.
 1. Experienced OPO staff may be able to prep/drape under certain circumstances. (patient should be prepped and draped prior to withdrawal. This is not a problem at our donor hospitals.)
 - ii. Surgeon stands right, assistant stands left with Mayo stand immediately cranial to the assistant (so the surgeon can see instruments and easily reach for them if needed)
 1. May need to modify Mayo placement in case of lung team
 - iii. Prep/drape in about 15 seconds if necessary. Use drape only without towels etc.
 - iv. Incision from sternal notch to pubis down to bone/fascia. Both surgeon and assistant lift abdominal wall to the ceiling (i.e. off the bowels) with left hand (alternative – penetrating towel clips), scalpel through fascia.

- v. Extend incision down to pubis (scalpel vs. scissors) first, then up to xiphoid
- vi. Divide falciform with scissors prior to placing retractor to avoid traction injury to liver
- vii. Place abdominal retractor
- viii. Assistant pulls cecum/TI towards head +/- towel/open lap pad for traction and uses Yankauer suction to help in case blood obscures field
- ix. Incise tissues directly above aortic bifurcation, get tie/umbilical tape with passer from Mayo a few cm cranial to planned cannulation site. Pull up on this tie to occlude lumen and prevent later blood spillage which can obscure vision.
 - 1. May use the passer clamp to occlude the distal aorta to keep field completely dry when making aortotomy
- x. Incise the aorta near bifurcation, insert cannula (need to relax traction on tie to let it pass) and state **"START THE FLUSH AND NOTE THE TIME."**
- xi. Tie the silk/umbilical tape to secure the cannula
- xii. Immediately adjacent to the distal aorta make big cut in IVC to vent and place Poole sucker adjacent.
- xiii. Ice in abdomen
- xiv. Open sternum, place retractor
- xv. Incise pericardium, identify descending thoracic aorta (remember the NGT probably removed so can't rely on the esophageal NGT as a landmark) and cross-clamp aorta
- xvi. Incise right atrium to provide an additional vent and replace Yankauer with a second Poole sucker to control the vented blood
- xvii. Return to abdominal aorta and check again to make sure cannula is in place, not disconnected, etc.
- xviii. Incise gallbladder and flush with cold saline until clear
- xix. Incise lateral/superficial CBD at the level of pancreatic head and flush with 18-gauge angiocath and cold saline
- xx. Place cross-clamp across root of mesentery to keep flush in the intended viscera instead of the bowels and cut the mesentery/remove the bowels. Continue the cut of the mesentery to ascending, transverse, and descending colon so all those warm bowels can be eviscerated (without actually dividing the bowel) and place more ice on what's left behind (i.e. the transplantable organs). This will also make cut-out much easier.
- d. Examine liver and make sure it is flushing well and appears transplantable (i.e. minimal steatosis). Biopsy if indicated.
- e. At this point, do the math to calculate warm-ischemia time and call recipient team to report if liver is good or not and if warm-ischemia time is within criteria so they can roll recipient into OR.
- f. Flush with at least 3-5 liters via aorta. Get nodes from the mesentery of the eviscerated bowels in the meantime.

- g. While flush finishes, cut the duodenum off of the pancreas, leaving the pancreas behind. Cut tissue along the lesser curve of the stomach right on the stomach to avoid an unrecognized aberrant left hepatic artery. Cut the short gastrics along the greater curve of the stomach and fully mobilize the stomach and esophagus to get them out of the way.
- h. Once flush is finished
 - i. Divide diaphragm at the esophageal hiatus
 - ii. Divide diaphragm to the right of the liver and flip liver into the chest, keeping ice on it
 - iii. Divide tissue between liver and right kidney by pulling down on right kidney while incising tissue
 - iv. Find left/right renal veins, divide IVC immediately superior
 - v. Finish the transection of all tissue to the right of the vertebrae using the division of the adrenal gland as a guide
 - vi. Assistant holds mesenteric clamp straight up to the ceiling. Directly below this clamp is the SMA
 - vii. Amputate SMA at its origin and peek into the aorta to make sure there aren't any high renal arteries. Divide aorta at this level leaving SMA/Celiac on the upper portion and all renal arteries on the lower portion (this way if there is an aberrant right hepatic artery it is safe)
 - viii. Divide pancreas distal and flip it towards the right so that the splenic artery/cealic etc. all come out during the cut-out.
 - ix. Divide the remainder of the right atrium and the thoracic aorta (below the clamp to keep warm blood from spilling). Put index finger of left hand into aorta (will see it poke out of the aortic incision by SMA) and middle finger of left hand into the IVC to lift liver.
 - x. Confirm pancreas is flipped to the right. Cut out liver along the spine and place in an ice bucket.
 - xi. Put ice all over kidneys
 - xii. On back table
 - 1. Flush 200-500cc UW retrograde via each hepatic vein
 - 2. Flush bile duct with cold UW several times
 - 3. Flush portal system – can use cut end of splenic vein as long as clamp is still on mesentery
 - 4. OPO packages liver, return to retrieve kidneys
 - xiii. Cut out kidneys en-bloc, separate on back table, flush and package (and biopsy if needed) according to OPO standard.
 - xiv. Retrieve iliac vessels and close