Endovascular Treatment of Hepatic Artery Stenosis following Liver Transplantation

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New Orleans

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Disclosure

I have no personal or professional financial relationships or interests with any proprietary entity producing healthcare goods/or services
Outline

Endovascular Rx of Hepatic Artery Stenosis

- Incidence and associated morbidity
- Etiology
- Clinical Presentation
- Diagnostic Evaluation
- Indications (and contra-indications) for Treatment
- Endovascular technique
- Results
- Complications
## Top 5 Liver Transplant Centers

<table>
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<tr>
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<th>2012</th>
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Source: OPTN/UNOS & Scientific Registry for Transplant Recipients 
Dec. 2015
Hepatic Artery Stenosis

Incidence and morbidity

Affects 5-11% of orthotopic liver transplants\(^1\)

Can Lead to biliary complications (ischemic)

Up to 65% chance of progressing to hepatic artery thrombosis (HAT)\(^2\)

Re-transplant required in up to 75% with HAT\(^3\)

Hepatic Artery Thrombosis \(\rightarrow\) 30-50% risk of Liver failure\(^4\)

Hepatic Artery Stenosis

Etiology

Common at anastomosis

Less frequently at terminal proper Hepatic/R and L hepatic bifurcation

Etiology

- Technical error
- Vessel redundancy/kinking
- Clamp injury
- Rejection
- Ischemia of vaso vasorum

**Hepatic Artery Stenosis**

**Clinical Presentation**

- Almost always asymptomatic
- Rarely causes transaminase elevation on its own
  - Other causes of LFT elevation should be aggressively investigated
- Worsening HAS will frequently be seen in patients with associated sepsis or rejection.
  - Underlying issue should be Rxed first
  - HAS will typically improve/resolve WITHOUT intervention in these circumstances
Hepatic Artery Stenosis
Diagnostic Evaluation

- **Duplex Ultrasound** (Phillips equipment @ Ochsner)
- **Studies performed:**
  - intra-operatively IF there are concerns
  - POD 1 and 7
  - 1,6 and 12 months
  - More frequent for donation after circulatory death (DCD) donors
Hepatic Artery Stenosis (HAS) - Diagnostic Evaluation

- Duplex Ultrasound

  - Severe HAS *suggested by:
    - Peak Systolic Velocity (PSV) of > 400-450 cm/sec
    - Resistive Index (RI) of <0.5
    - Presence of Tardus Parvus waveforms

*Lall NU, Bluth EI, Sternbergh WC III. Ultrasound findings after endovascular stent deployment in transplant liver hepatic artery stenosis. AJR (Am J Roentgenol);202: 234-40, 2014
Tardus Parvus: HA Stenosis and Post Angioplasty

Pre

MHA RI = .33

LHA RI = .38

Post

MHA RI = .63

LHA RI = .65
Hepatic Artery Stenosis (HAS)

Diagnostic Evaluation

- **Duplex Ultrasound**

- **Severe HAS** suggested by:
  - Peak Systolic Velocity (PSV) of > 400-450 cm/sec
  - Resistive Index (RI) of <0.5
  - Presence of Tardus Parvus waveforms

- Rarely, critical HAS has no velocity elevation
  - But has very low RI and + tardus parvus waveforms

*Lall NU, Bluth EI, Sternbergh WC III. Ultrasound findings after endovascular stent deployment in transplant liver hepatic artery stenosis. AJR (Am J Roentgenol);202: 234-40, 2014
Duplex: “Common hepatic flow not well visualized, possibly thrombosed. R and L hepatic Resistive index (RI) 0.35-0.37 with tardus parvus waveforms”

99+% Proper Hepatic Stenosis
Occlusive with 0.014 wire
After 2.75 x 18 DES placement
Hepatic Artery Stenosis
Diagnostic Evaluation

- In patients with severe HAS by US, a CTA is usually performed for endovascular case planning (rarely to confirm the Dx)
  - Orientation of celiac
    - Use brachial approach if significant caudal angulation (~30%)
  - Aberrant inflow
    - Recipient hepatic inflow via SMA from replaced R hepatic
    - Unexpected high grade celiac artery stenosis with hepatic inflow through the SMA via retrograde GDA flow
    - Aorta-hepatic conduit
Hepatic Artery Stenosis
Indications for Endovascular Rx

- **Severe HAS by duplex**
  - PSV >400-450, RI <0.5, + tardus parvus waveforms

- **Minimum of 3 wk post-op**
  - Completely arbitrary – my fear of dilating a fresh anastomosis
  - Peri-operative (typically POD1) HAT is managed surgically

- **Contraindications**
  - Concurrent rejection or sepsis (HAS usually improves after Rx of primary issue)
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Hepatic Artery Stenosis Rx

Technique of delivering a stable platform

- Femoral or Brachial (30%) approach
  - 6 fr RDC-1 guide (femoral), 5 fr multipurpose sheath (brachial)
- 0.035 stiff angled glidewire into GDA followed by 5 fr glide catheter
- Sheath or guide then **carefully telescoped** into the distal common hepatic over catheter/wire
- 0.035 wire and 5 fr catheter removed
Hepatic Artery Stenosis Rx
Technique for Rx

- **DA imaging (15 fps)** frequently better than DSA

- **0.014 platform** (choice PT regular or extra support my fav)
  - Use the least stiff wire that will allow balloon/stent to track

- **Rapid exchange coronary balloons** (2-5 mm)

- **Coronary stents**
  - 2-5mm diameter, 8-28mm length
  - Prefer DES if < 3.5mm diameter
Technique

99% Stenosis of proper hepatic artery

Main HA

coronary stent placement
Technique

Balloon expandable coronary stent

Completion hepatic angiogram
Technique

Filling of hepatic vasculature

PRE

POST
Buddy Wire Technique

Left HA stenosis

Main HA

Right HA occlusion
Buddy Wire Technique

Pre-dilation with buddy wire in left HA

Balloon expandable stent in right HA
Buddy Wire Technique

Stenting of left hepatic artery
Buddy Wire Technique

PRE

POST
3.5 x 18 DES

2.25 x 12 DES
Primary stent placement for hepatic artery stenosis after liver transplantation

Linda Le, MD, William Terral, MD, Nicolas Zea, MD, Hernan A. Bazan, MD, Taylor A. Smith, MD, George E. Loss, MD, Edward Bluth, MD, and W. Charles Sternbergh III, MD, New Orleans, La

- Aug 2009 – Dec 2013
- N=62 interventions in 42 patients
- 6.4% (42/654 Liver Transplants) need for HAS intervention
- Most interventions <3 months after transplant
Results

Time to Initial Intervention

Within 30 days  |  Within 3 months  |  After 3 months

- 6
- 21
- 15

Mean time = 82.2 ± 56 days

2/3 within 3 months of transplant
62 Interventions

42 Initial Interventions

- 25 initial stent
  - 5 Drug-eluting

- 17 PTA

20 Re-interventions

- 15 stent
  - 4 Drug-eluting

- 5 PTA

Median F/U = 19.1 ± 15 months
Results

95% Technical Success (59/62)
3.2% HAT risk
2.4% 30-day mortality

4.8% Re-transplant Rate
(n=3)
- HAT
- Recurrent HCC
- cholangitis

4.8% Complication Rate
(n=3)
2 dissections leading to HAT
Hepatic artery extravasation,
brachial artery thrombosis
PTA vs. Stent Patency

![Graph showing PTA vs. Stent Primary Patency. The graph indicates that the patency rates for Stent and PTA are compared over time, with Stent showing higher patency rates at all time points. The table below the graph details the number of patients at risk for each group at different time points.]

**Legend:**
- **STENT**
- **PTA**

**No. at Risk**

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*P = 0.19*

PTA vs. Stent Patency

PTA vs. Stent Primary Patency

P=0.19

No. at Risk

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Primary Assisted Patency

24 month = 93%

From the Southern Association for Vascular Surgery

Complications after endovascular treatment of hepatic artery stenosis after liver transplantation

Leighton E. Goldsmith, MD, Kristy Wiebke, DO, John Seal, MD, Clayton Brinster, MD, Taylor A. Smith, MD, Hernan A. Bazan, MD, and W. Charles Sternbergh III, MD New Orleans, La

ABSTRACT

Background: Hepatic artery stenosis (HAS) after liver transplantation can progress to hepatic artery thrombosis (HAT) and a subsequent 30% to 50% risk of graft loss. Although endovascular treatment of severe HAS after liver transplantation has emerged as the dominant method of treatment, the potential risks of these interventions are poorly described.

Methods: A retrospective review of all endovascular interventions for HAS after liver transplantation between August 2009 and March 2016 was performed at a single institution, which has the largest volume of liver transplants in the United States. Severe HAS was identified by routine surveillance duplex ultrasound imaging (peak systolic velocity >400 cm/s, resistive index <0.5, and presence of tardus parvus waveforms).

Results: In 1129 liver transplant recipients during the study period, 106 angiograms were performed in 79 patients (6.9%) for severe de novo or recurrent HAS. Interventions were performed in 99 of 106 cases (93.4%) with percutaneous transluminal angioplasty alone (34 of 99) or with stent placement (65 of 99). Immediate technical success was 91%. Major complications occurred in eight of 106 cases (7.5%), consisting of target vessel dissection (5 of 8) and rupture (3 of 8). Successful endovascular treatment was possible in six of the eight patients (75%). Ruptures were treated with the use of a covered coronary balloon-expandable stent graft or balloon tamponade. Dissections were treated with placement of bare-metal or drug-eluting stents. No open surgical intervention was required to manage any of these complications. With a median of follow-up of 22 months, four of eight patients (50%) with a major complication progressed to HAT.
Study Design

- Retrospective Review: August 2009 – March 2016
- Tertiary care institution
  - Ochsner Clinic Foundation, New Orleans, LA
  - Largest US volume of OLTx since 2011
- Objective
  - Define potential risks associated with early intervention for HAS
  - Describe salvage techniques for endovascular repair
- IRB Approved
Results

- 79 pts, 1129 OLTx in 6.5 yrs
- 6.9% HAS Rate

79 Patients

19

60

Interventions

- 34 PTA Alone
- 65 Stent
Results

- 79 pts, 1129 OLTx in 6.5 yrs
  - 6.9% HAS Rate
- n=106 angiograms

- 99 Interventions
  - 7 Diagnostic
  - 34 PTA Alone
  - 65 Stent

79 Patients

- 19 Female
- 60 Male
Results

- 79 pts, 1129 OLTx in 6.5 yrs
  - 6.9% HAS Rate
- n=106 angiograms

**99 Interventions**

- 7 Diagnostic
  - Mean Age = 51 yo (Range 11-72)
  - Femoral Approach = 72.6%
- Median Time to Intervention = 71 days

- Interventions
  - 34 PTA Alone
  - 65 Stent

79 Patients

19

60
106 Angiograms for HAS

7 Initial Diagnostic

73 Initial Interventions

46 Initial Stent

27 PTA

26 Re-interventions

6 PTA

19 Stent

1 Diagnostic

Re-intervention Rate = 26.5% (21/79)

Time to Re-intervention = 97 days
Technical Success

- n=2
  - Major Complication
  - HAS could not be treated

- n=2
  - Major Complication
  - HAS Aborted

- n=5
  - >30% Residual Stenosis

91% (90/99)
Major Complications

3 Ruptures, 5 dissections: 7.5% rate (8/106)
Major Complications

- 3 Ruptures, 5 dissections: **7.5% rate** (8/106)

- 6/8 (75%) had successful endovascular Rx
  - Ruptures all successfully Rxed with Jomed covered stent (n=2) or balloon tampanode (n=1)
  - Dissections Rxed with stents if true lumen access could be obtained
  - No open Rx was required
Major Complications

- 3 Ruptures, 5 dissections: **7.5% rate** (8/106)
- 6/8 (75%) had successful endovascular Rx
  - Ruptures all successfully Rxed with Jomed covered stent (n=2) or balloon tampanode (n=1)
  - Dissections Rxed with stents if true lumen access could be obtained
  - No open Rx was required
- However, 4/8 patients (50%) went on to HAT, compared to 1.4% (1/71) in the non-complication cohort (P<0.001)
1 year all cause mortality

- Complication Cohort: 12.5% (1/8)
- Non-complication Cohort: 7% (5/71)

P = .484
Risk Factors for Complications

Tortuosity

- Non-complication Cohort
  - 34.6% (34/98) interventions had tortuous anatomy
- Complication Cohort
  - 75% (6/8) interventions had tortuous anatomy

P = .05

2 fold increase
Risk Factors for Complications

Re-transplants

- **Non-complication Cohort**
  - 12.6% (9/71) patients had ≥2 liver transplants

- **Complication Cohort**
  - 37.5% (3/8) patients had ≥2 liver transplants

P = .097

3 fold increase
Hepatic Artery Rupture

- 11 y/o boy with Budd–Chiari
- 1st liver Transplant 12/10/13
  - Open Exploration for hepatic artery thrombosis
- 2nd Liver Transplant 12/12/13
- Colon perforation/exploration 12/24/13
- Severe HAS, angio on 1/13/14 (POD 31)
Proper Hepatic Artery Rupture → Extravasation
3x20 Balloon Tamponade
Resolution of HAS & hepatic rupture
Hepatic Artery Dissection
Proper Hepatic Artery Dissection

True Lumen

False Lumen
Coronary Steerable Catheter
3.5x33
Bare Metal Stent
Meta-analysis

- Stent placement vs angioplasty for HAS after liver transplant: a meta-analysis of case series
  - Rostambeigi et al (U Minnesota), Eur Radiol 2013 23:1323
  - 263 interventions from 26 studies
    - 147 PTA, 116 stent
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Procedure success: 89% (PTA) vs 98% (stent)
Complication rate: 16% (PTA) vs 19% (stent)
Arterial Patency: 76% (PTA) vs 68% (stent)
Re-intervention: 22% (PTA) vs 25% (stent)
Re-transplantation: 20% (PTA) vs 25% (stent)

Conclusion: PTA and stent Rx are equivalent
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## Literature, HAS intervention

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Take home clinical pearls

Hepatic artery Intervention

- Only Rx high grade stenosis
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  - Overall, I Rx <50% of cases I’m asked to see
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- Don’t treat in setting of rejection or sepsis

- Case plan carefully (femoral vs brachial)

- Meticulous technique is essential

- Can be technically challenging/unforgiving
  - Experienced in rapid exchange 0.014 systems
  - Need availability of bail-out devices
Summary

Endovascular Rx of Hepatic Artery Stenosis

• Endovascular Intervention for HAS is effective with excellent primary-assisted patency rates

• Primary stent placement (particularly DES) appears to reduce the need for secondary intervention in my experience
  • Meta-analysis suggest equivalent results

• Severe hepatic artery tortuosity and/or re-transplantation increase the risk of a complication by 2-3 fold
Summary
Endovascular Rx of Hepatic Artery Stenosis

- Complication rate (7.5%) is acceptable in light of the frequently challenging anatomy
- While most major complications can be Rxed endovascularly (75%), the subsequent rate of HAT is very high (50% vs 1.4%)
- Prudent case selection is essential