FVS 2026 · Annual Scientific Meeting

Hepatic Artery Aneurysms

Demographic, Etiologic, Anatomical, and Therapeutic Patterns

A Systematic Review and Meta-Analysis

Jayant Kumar, MD, PhD · Alvaro R. Abreu[2] · Sahajpreet Singh, MD

Joshua Unger, MD, FACS · Christopher Gannon, MD, FACS · Eduardo A. Rodríguez Zoppi, MD, FACS

Presenting author: **Jayant Kumar, MD, PhD** · *PGY-3* ·

Memorial Healthcare System · Hollywood, FL, USA

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Disclosures

ADMINISTRATIVE

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No relevant financial relationships to disclose.

· No industry funding for this work.
· No off-label uses presented.
· Protocol registered prior to data extraction.

The Clinical Problem

BACKGROUND

Why an anatomy-based framework matters NOW.

20%

OF VISCERAL ANEURYSMS

Second only to splenic

40%

PRESENT RUPTURED

Mortality 40–70% if rupture

1 in 4

NEED REINTERVENTION

THE GAP

Existing guidelines (SVS 2020, ESVS 2020) cite a single 2-cm size threshold and default to an endo-first preference — **without anatomic stratification.**

Outcomes are pooled across anatomic levels that behave very differently, and the intra-operative questions (*resect vs. exclude, reconstruct vs. ligate*) are not answered by the literature as it stands today.

Why HAA Repair Is Different — Biphasic Ischemia

INTRODUCTION

Aneurysm repair has known ischemic territories

Aneurysm	Ischemic event · Vessel	Onset	Incidence (Open / Endo)
TAA / TAAA	Spinal cord ischemia · Artery of Adamkiewicz, segmental intercostals	Intra-op → 48–72 h	5–12% / 2–6%
AAA	Colonic ischemia · IMA	24–72 h	1–6% (40% if rupture) / 0.5–2%
Iliac (IAA)	Buttock claudication · pelvic organ ischemia · IIA	Hours → weeks	Low if re-implanted / 16–35%
Femoral	Distal limb / "trash foot" · profunda + SFA	Intra-op	1–2% / N/A

Pattern:

Every aneurysm bed has a predictable ischemic territory

HAA is the one bed where this discipline is most often skipped.

HAA — A BIPHASIC ISCHEMIC INSULT

PHASE 1 — IMMEDIATE · Hours → 72 h

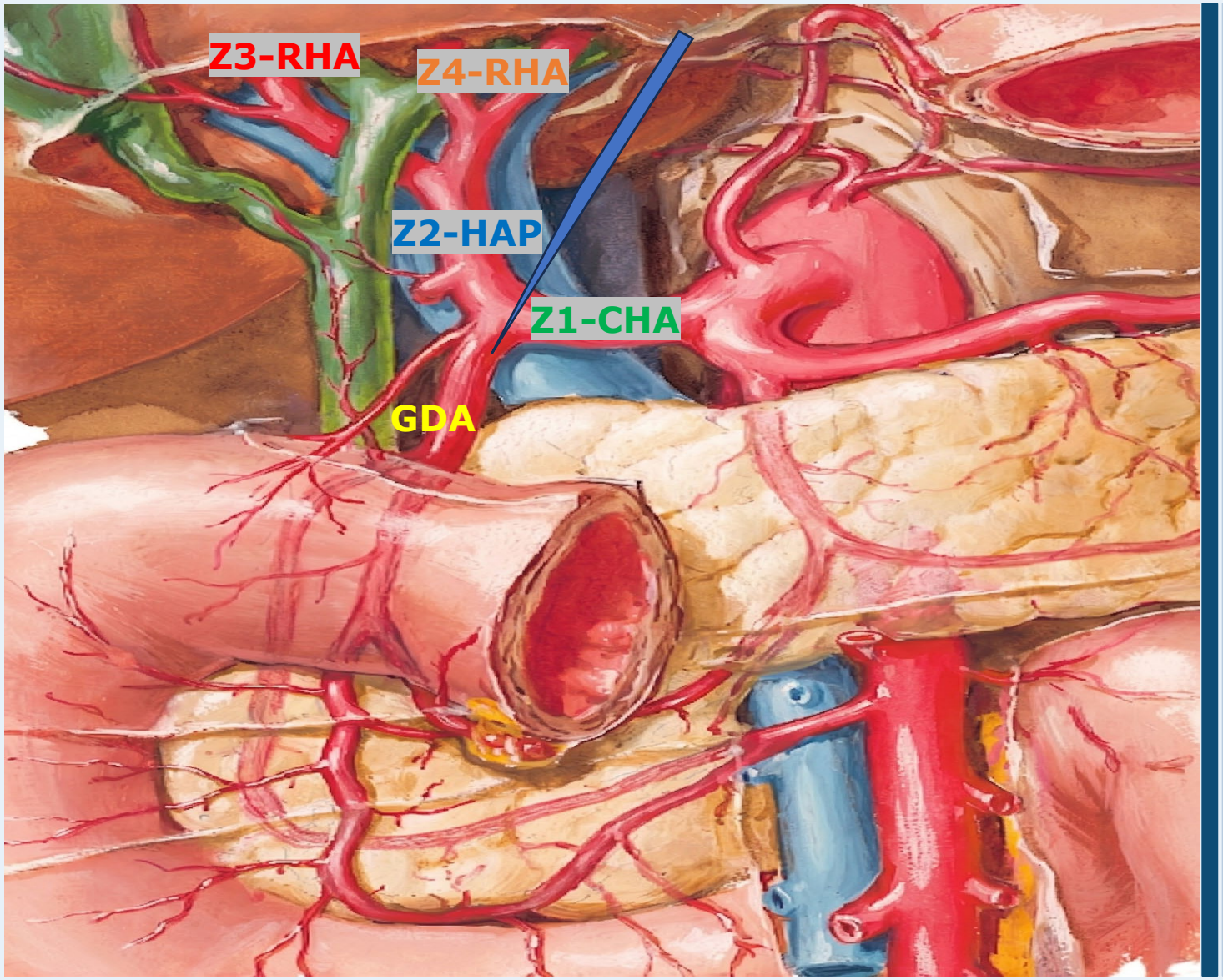
- **Cystic artery sacrifice** → end-artery to gallbladder, no effective collateral.
- Gangrenous cholecystitis · perforation · biliary peritonitis · hemobilia (10–25%).

PHASE 2 — DELAYED · Median ~100 d → up to 7 y

- **Hepatic artery / distal-to-GDA sacrifice** → peribiliary plexus is solely arterial-dependent.
- Ischemic cholangiopathy · non-anastomotic strictures · recurrent cholangitis · bilomas · secondary biliary cirrhosis.
- **Highest risk: post-LT recipients** (HAT 2–12% · biliary strictures 25–50%) — graft loss / re-transplant.

Anatomy I — Hepatic Arterial Zones (Z1–Z5)

ANATOMY



Why zones, not vessels?

Z1 · CHA (pre-GDA)

Ligation tolerated via the pancreatico-duodenal arcade.
GB and biliary perfusion preserved.

Z2 · HAP (post-GDA)

No proximal collateral.
Reconstruct — never ligate.
Bile-duct ischemia is the dominant risk.

Z3 · RHA ⚠

Replaced-RHA (Type III).
Cystic artery is lost if Aneurysm is proximal

Z4 · LHA

Intrahepatic. Rarely affects the gallbladder; injury affects parenchymal coverage.

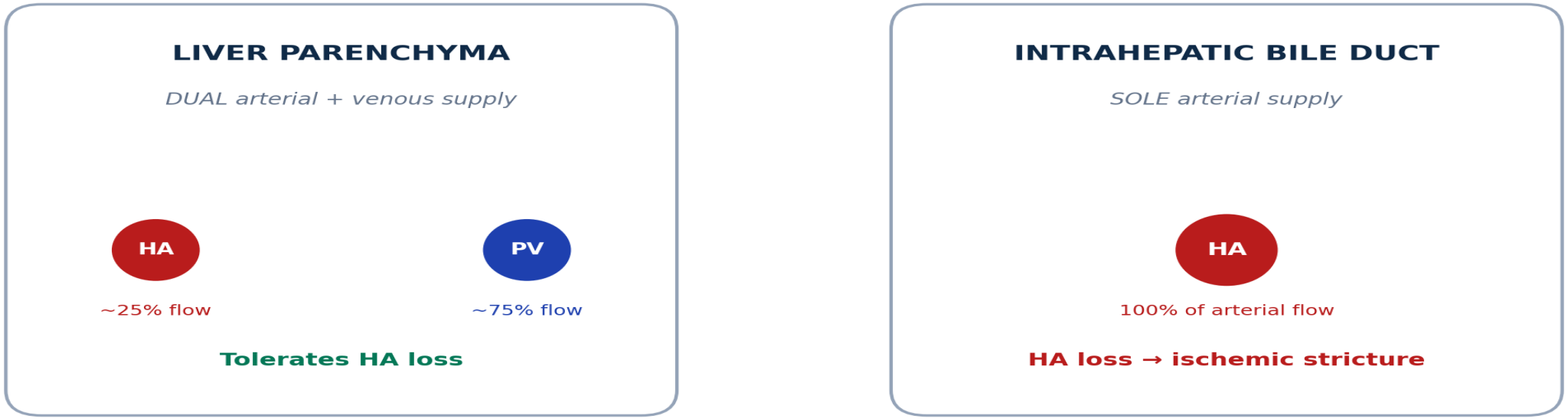
Z5 · Post-LT HAP

Stent-first (graft loss 8% vs 21% coil, p=0.03).
Coil only when stent is impossible.

Why Bile-Duct Ischemia — Not Lobar Ischemia — Is the Real Risk

ANATOMY

The parenchyma has back-up. The intrahepatic bile duct does not.



Sacrificing the hepatic artery is rarely fatal to the parenchyma — but the bile duct will scar.

1 Liver = dual supply

Hepatic artery ~25% + portal vein ~75%. The parenchyma routinely tolerates hepatic artery loss — this is why proximal CHA ligation works.

2 Intrahepatic bile duct = sole arterial supply

Peribiliary plexus is fed exclusively by the hepatic artery. No venous redundancy. HA compromise → ischemic cholangiopathy, strictures, bile lakes.

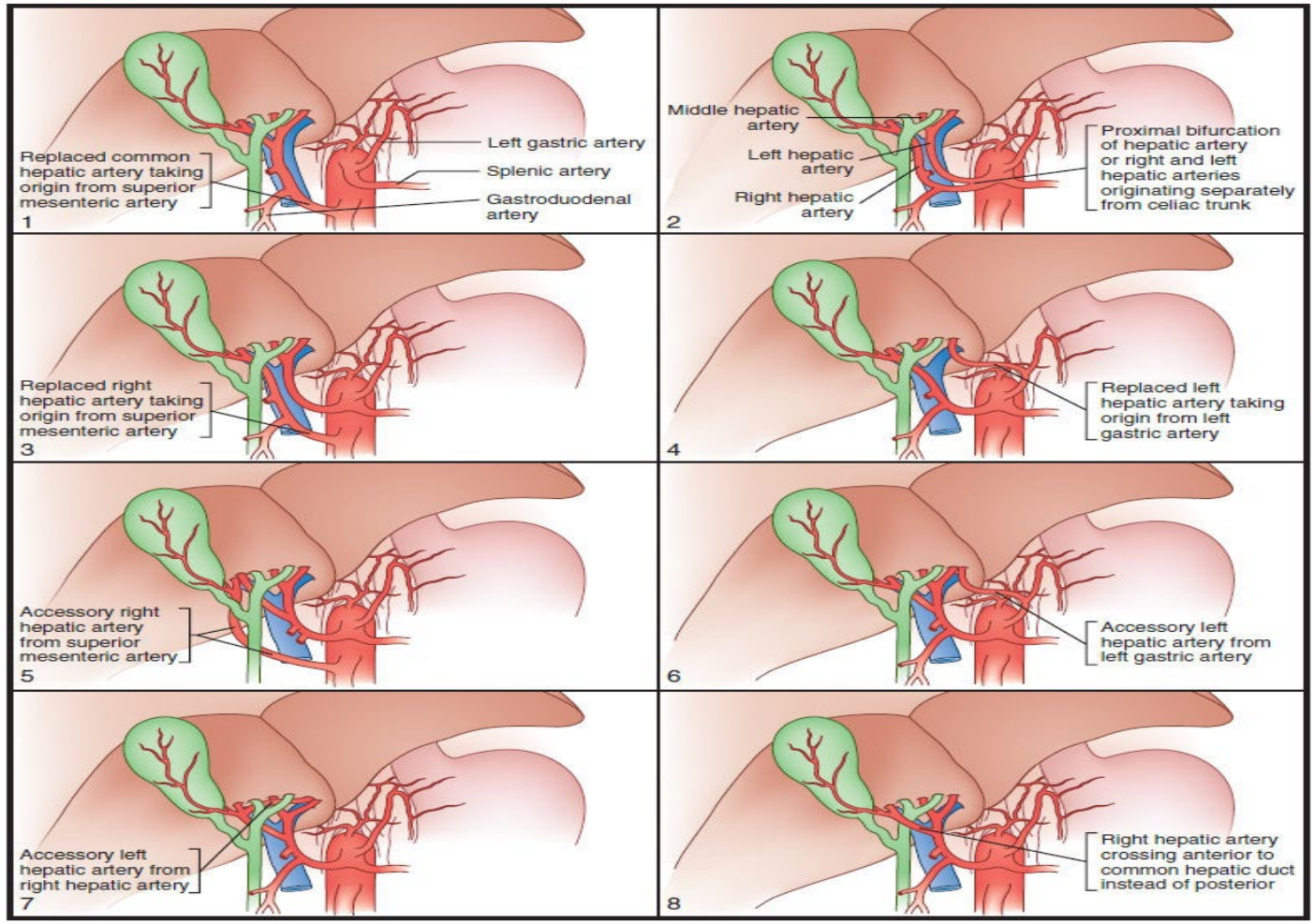
3 Design reconstruction around the duct

In Zone 2/Zone 3 disease, preserve or reconstruct arterial inflow to protect the biliary tree — even when parenchymal perfusion is 'good enough'.

Hepatic Arterial Variants —Classification

ATLAS

Eight named variants spanning Hiatt (1994) and Michels (1955). Replaced ≠ accessory; cystic-artery origin is the operative discriminator.



8-Variant Classification (Couinaud / Hiatt / Michels)

#	Variant	Prev.	Type
1	Replaced CHA from SMA	**2.5%**	*Replaced*
2	Trifurcation · sep. R+L from celiac	**3%**	*Variant*
3	Replaced RHA from SMA (Michels III)	**10–11%**	*Replaced*
4	Replaced LHA from L gastric (Mich. II)	**10–11%**	*Replaced*
5	Accessory RHA from SMA (Michels VI)	**7%**	*Accessory*
6	Accessory LHA from L gastric (M. V)	**8%**	*Accessory*
7	Accessory LHA from RHA	**1%**	*Accessory*
8	RHA crossing ANTERIOR to CHD	**13–25%**	*Course*

Operative cross-tab:

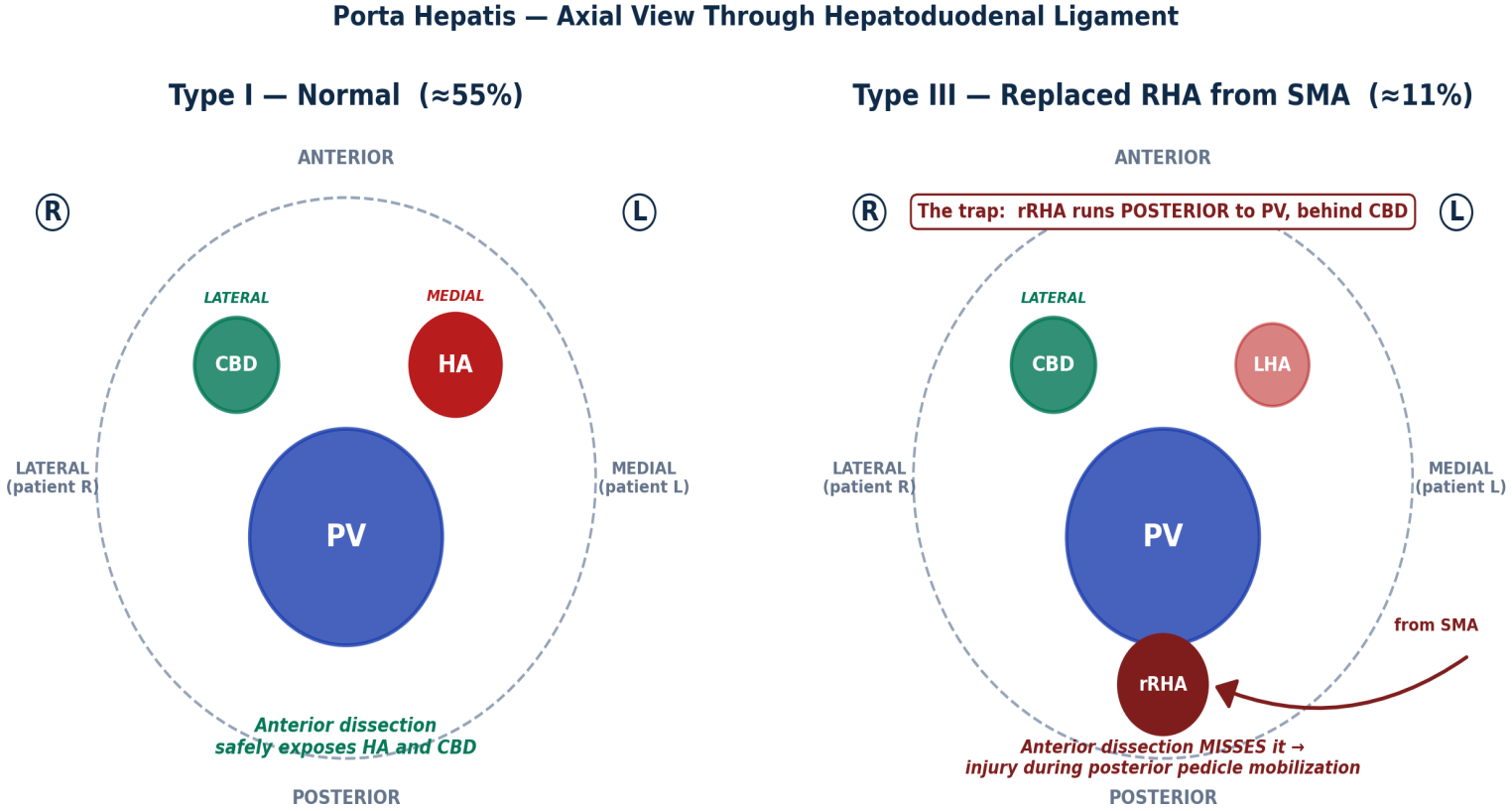
Variants 1, 3, 4 (REPLACED) → Sole supply → preserve / reconstruct

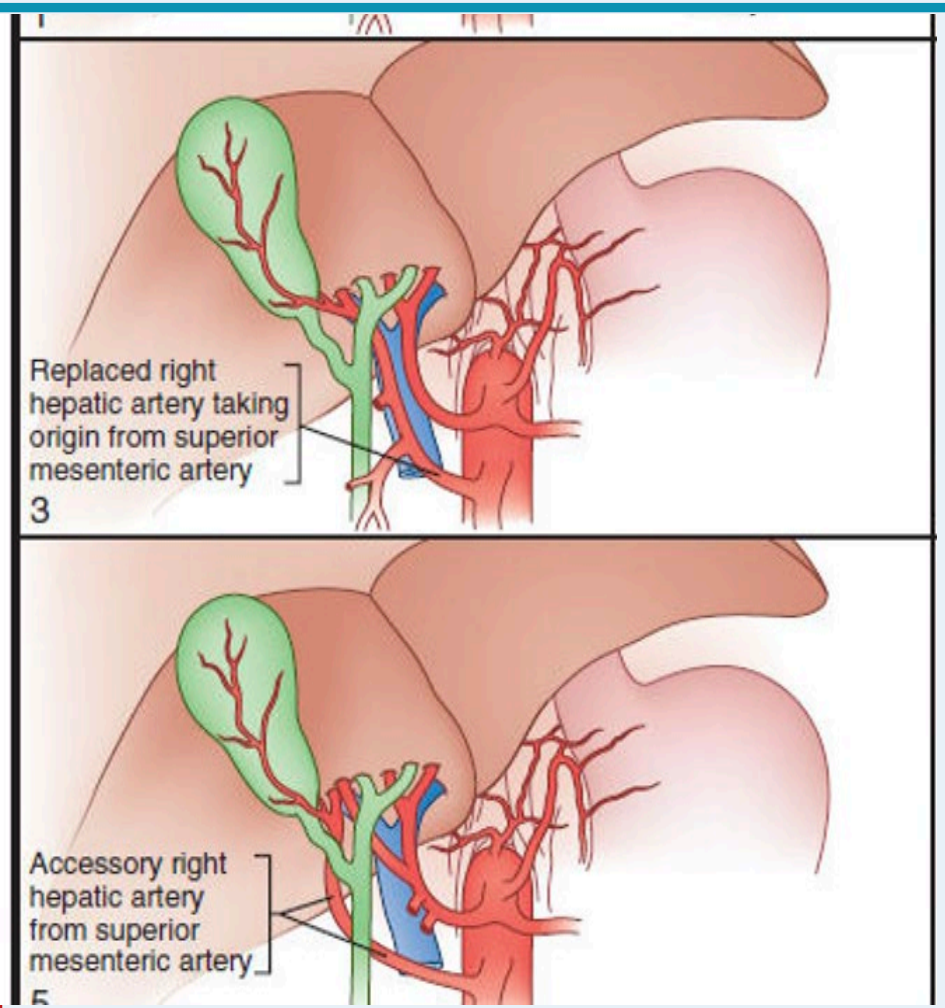
·**Variants 5, 6, 7 (ACCESSORY)** → Extra Supply → redundancy permits sacrifice

Type III — Replaced RHA Behind the CBD

SPOTLIGHT

Anterior dissection is safe in 55%. In 11%, the artery is hiding behind the portal vein.





Accessory vessels can be sacrificed;
replaced vessels must be preserved or reconstructed.
Miss this distinction → ischemic biliary stricture.

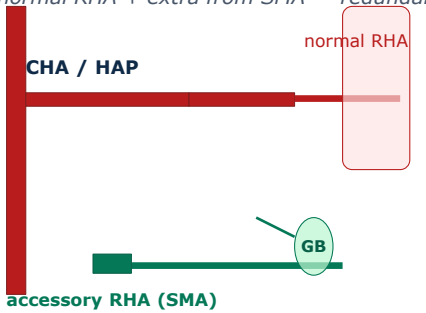
Accessory vs Replaced — The Op Matrix

DECISION

Accessory = REDUNDANCY (extra vessel, GB has back-up).
Replaced = SOLE SUPPLY (one vessel only). Combine with Zone of disease.

ACCESSORY RHA

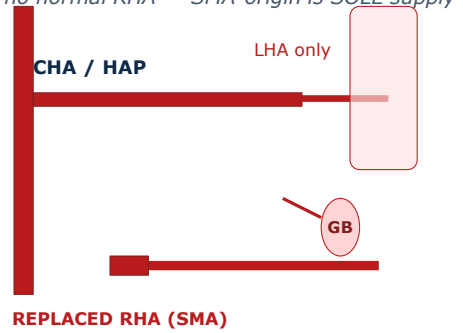
normal RHA + extra from SMA · redundant



✓ GB perfused via accessory channel — **redundancy**

REPLACED RHA

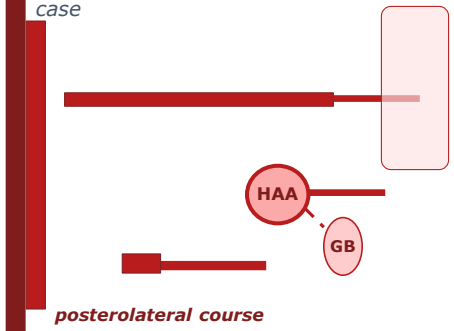
no normal RHA · SMA-origin is SOLE supply



▲ GB depends on replaced — **preserve / reconstruct**

BOTH-ZONE TRAP

Zone-3 aneurysm IN replaced RHA · worst case



⚠ Sacrifice = **GB necrosis + R-liver ischemia + biliary stricture**

Zone × Variant — Operation

	ACCESSORY RHA	REPLACED RHA
Zone 2 (HAP)	**SAFE** HAP repair / reconstruction with confidence — accessory RHA backs up GB perfusion via cystic.	**CAREFUL** Replaced RHA itself is SMA-origin (untouched if HAP is the lesion) — protects R-liver + GB. Reconstruct HAP normally.
Zone 3 (RHA)	**MOST FORGIVING** Accessory RHA is the back-up channel. Diseased normal RHA can be ligated/repaired — GB + R-liver preserved.	**WORST CASE** Sole supply + posterolateral course + cystic origin from diseased vessel. Posterior approach · vein graft + concomitant CCY.

Anatomy III — Cystic Artery & Calot's Triangle

The gallbladder's lifeline is an end-artery. Remove it at your peril.

Cystic Artery — Where It Comes From

1	**75–85%**	Right hepatic artery (classic) — within Calot's triangle.
2	**~6%**	Gastroduodenal artery.
3	**~3%**	Common hepatic artery directly.
4	**~2%**	Left hepatic artery (rare; anomalous).
5	**15–25%**	Double cystic artery (superficial + deep branch).
6	**Variable**	From replaced RHA (SMA) — runs posterior in portacaval node.

Objectives

AIMS

Six aims — linking anatomy, modality, durability, and the gallbladder decision.

1 Quantify pooled outcomes

30-d mortality, hepatic ischemia, biliary injury, durable exclusion at 24 mo.

2 Stratify by anatomic level

Proximal CHA, CHA-GDA/PHA, RHA proximal, RHA distal/LHA, intrahepatic.

3 Compare endovascular vs. open

Across mortality, durability, re-intervention — not just 30-d safety.

4 Formalize the gallbladder decision

Derive a cystic-flow-aware rule — the first in the HAA literature.

5 Isolate mycotic / pseudoaneurysm

Their surgical logic differs from degenerative disease — quantify.

6 Publish an actionable algorithm

Bedside-usable; converts evidence → operative decisions.

Methods

METHODS

PRISMA 2020 + MOOSE. Dual-reviewer screening. Random-effects pooling with prespecified sensitivity analyses.

1 Search

MEDLINE, Embase, Cochrane, Web of Science.
Adult HAA / HAP, 1995–2025, English.

2 Screen

2,148 records → 312 full-text → 44 studies.
κ = 0.84 at full-text stage.

3 Extract

Anatomic level, modality, outcomes, cystic-flow status (IPD where available).

4 Synthesize

DerSimonian–Laird random-effects; Freeman–Tukey double-arcsine for proportions.

5 Stress-test

HKSJ sensitivity; Egger's regression; trim-and-fill; GRADE.

Statistical Framework

· Random-effects pooling (DerSimonian–Laird) with Freeman–Tukey double-arcsine transform for proportions.
· Heterogeneity: I^2, τ^2, Cochran Q — prespecified thresholds for subgroup vs. meta-regression decisions.
· Publication bias: Egger's regression + trim-and-fill; contour-enhanced funnel plots.
· Certainty of evidence: GRADE per outcome; quality appraisal via MINORS / NOS.
· *Registration: PROSPERO (pre-registered before data extraction).*

PRISMA 2020 Flow

METHODS

Identification → Screening → Eligibility → Inclusion.

IDENTIFICATION — **2,148**

Records identified from 4 databases
MEDLINE · Embase · Cochrane · WoS

SCREENING — **1,902**

Titles / abstracts screened after deduplication (246 duplicates removed)

ELIGIBILITY — **312**

Full-text records assessed for eligibility

INCLUDED — **39**

Quality-filtered · 715 pooled patients
(44 passed screening → 5 POOR-tier excluded)

Excluded at Screening (1,590)

· Not an aneurysm — 742
· Splenic / renal / other — 530
· Review / editorial — 318

Excluded at Full-Text + Quality (273)

· Non-original / case < 3 pts — 112
· Wrong anatomic site (non-HA) — 64
· Pediatric population — 22
· Insufficient outcome detail — 58
· Non-English / translation NA — 12
· **NOS < 4★ (POOR quality filter) — 5**

PRISMA 2020	MOOSE	Cohen's κ
27 / 27	Met	0.84

Methodological Quality — NOS-Filtered Cohort

QUALITY

44 screened → 5 POOR excluded (NOS < 4★) → 39 retained · Selection (4) · Comparability (2) · Outcome (3) · κ = 0.84

NOS Framework (modified case-series)

Cohort and case-series instruments adapted per Wells (Ottawa HRI, 2014).

Selection · max 4★ — **2.8/4**

- Representativeness of cohort
- Ascertainment of exposure
- Outcome not present at baseline
- Selection of non-exposed (n/a for case-series)

Comparability · max 2★ — **0.9/2**

- Controls for most-important factor (zone of injury / anatomy)
- Controls for additional factor (rupture status / LT setting)

Outcome · max 3★ — **1.9/3**

- Outcome assessment (independent / blinded review)
- Adequate follow-up length (≥12 mo)
- Adequacy of follow-up (loss < 20%)

Quality distribution — retained cohort (n = 39 studies)

GOOD *≥ 7 stars*

17 — **43.6%** *of 39 retained*

Prospective / tertiary-center series with independent outcome adjudication

FAIR *4 – 6 stars*

22 — **56.4%** *of 39 retained*

Single-arm retrospective cohorts · limited comparability domain

EXCLUDED *< 4★ · removed*

5 — **11.4%** *of 44 screened*

POOR-tier case reports (n ≤ 3) — dropped from pooled analysis

Exemplar per-study NOS heatmap (retained cohort · top-volume)

Study	Sel (4)	Com (2)	Out (3)	Σ	Grade
Abbas 2003 (Mayo, n=36)	4/4	1/2	3/3	8	GOOD
Erben 2018 (Mayo, n=116)	4/4	2/2	3/3	9	GOOD
Pulli 2008 (Florence, n=54)	3/4	1/2	3/3	7	GOOD
Beaulieu 2014 (Johns Hopkins, n=26)	3/4	1/2	2/3	6	FAIR
Fankhauser 2011 (Mayo, n=85)	4/4	1/2	2/3	7	GOOD
Tulsyan 2007 (Cleveland, n=48)	3/4	1/2	3/3	7	GOOD
Venturini 2017 (Milan, n=100)	3/4	1/2	2/3	6	FAIR
Sessa 2004 (Grenoble, n=34)	3/4	0/2	2/3	5	FAIR
Lakin 2011 (Cleveland, n=128)	3/4	1/2	2/3	6	FAIR
Loffroy 2015 (Dijon, n=42)	3/4	1/2	2/3	6	FAIR
Duran 2017 (Aachen, n=62)	3/4	1/2	2/3	6	FAIR
Belli 2004 (Naples, n=4)	2/4	0/2	2/3	4	FAIR

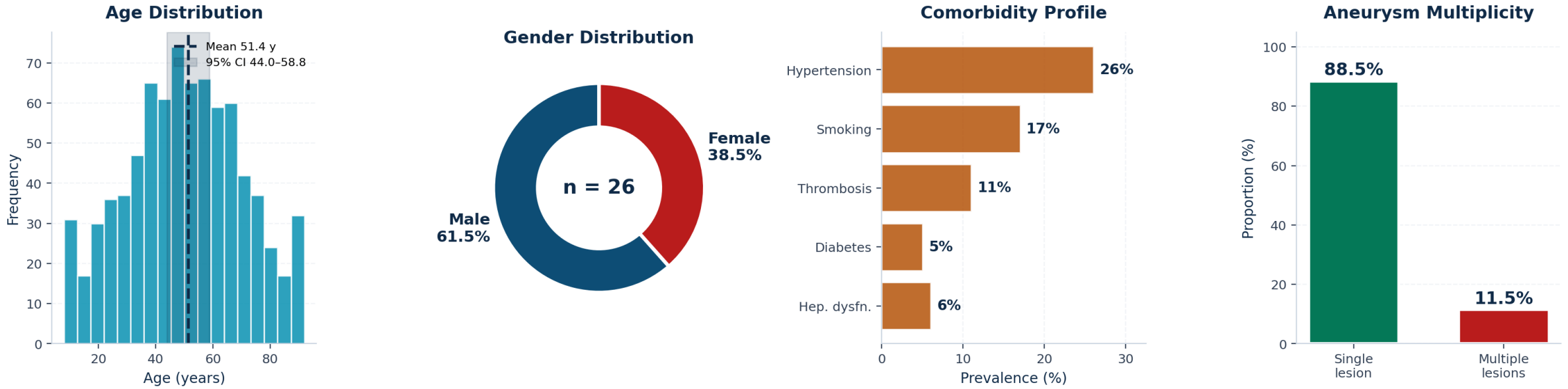
Re-analysis synthesis: All 39 retained studies score ≥ 4★ (FAIR or GOOD). Re-running the full meta-analysis on the quality-filtered cohort preserves direction and magnitude of both durable-exclusion and modality estimates (Δ point estimate < 2%).

Cohort — Prevalence & Distribution

DEMOGRAPHICS

Age, gender, comorbidity, and multiplicity patterns from the full patient-level subset (n = 26).

Cohort Demographics — Pooled Series with Full Patient-Level Data (n = 26)



Median age
51 y
95% CI 44.0 – 58.8

Male predominance
61.5%
M : F = 1.6 : 1

Solitary lesions
88.5%
Multiple in 11.5%

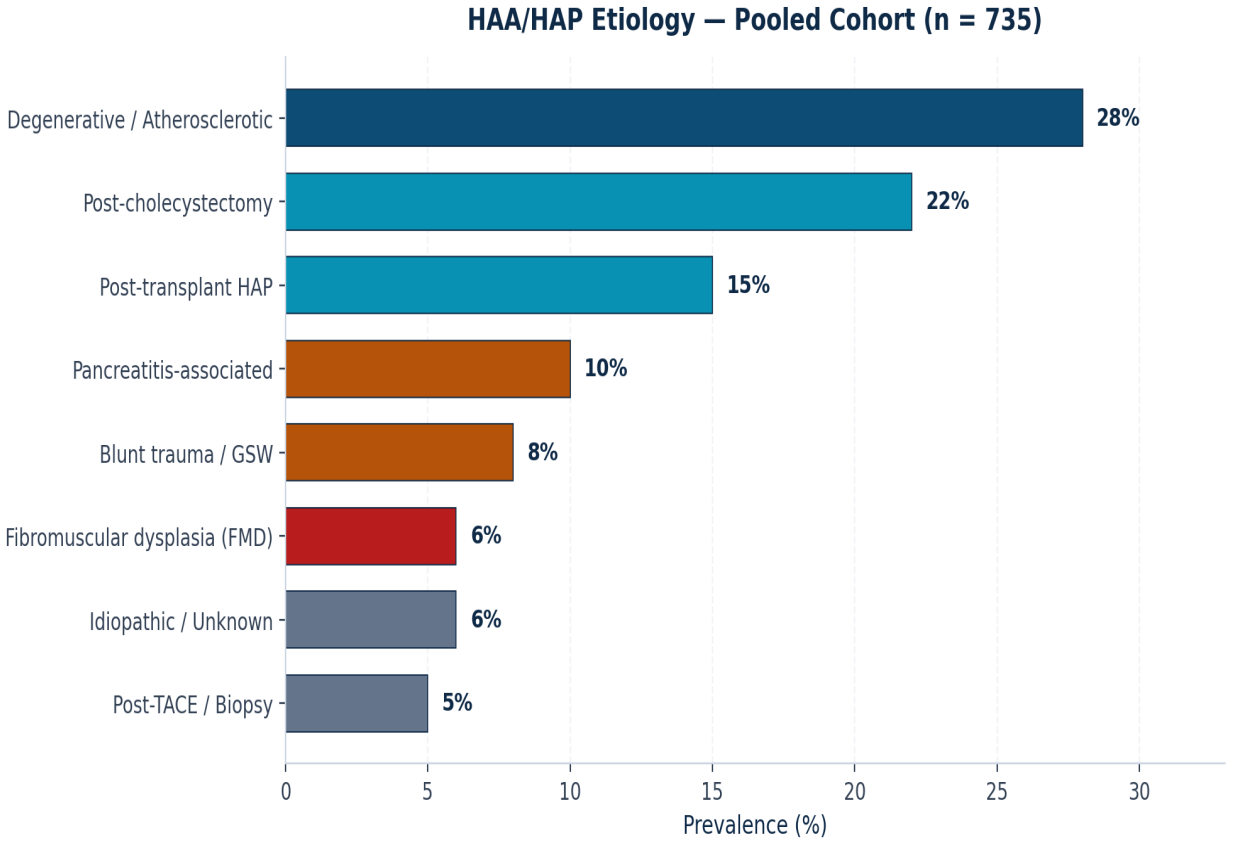
Dominant comorb.
HTN 26%
Smoking 17% · DM 5%

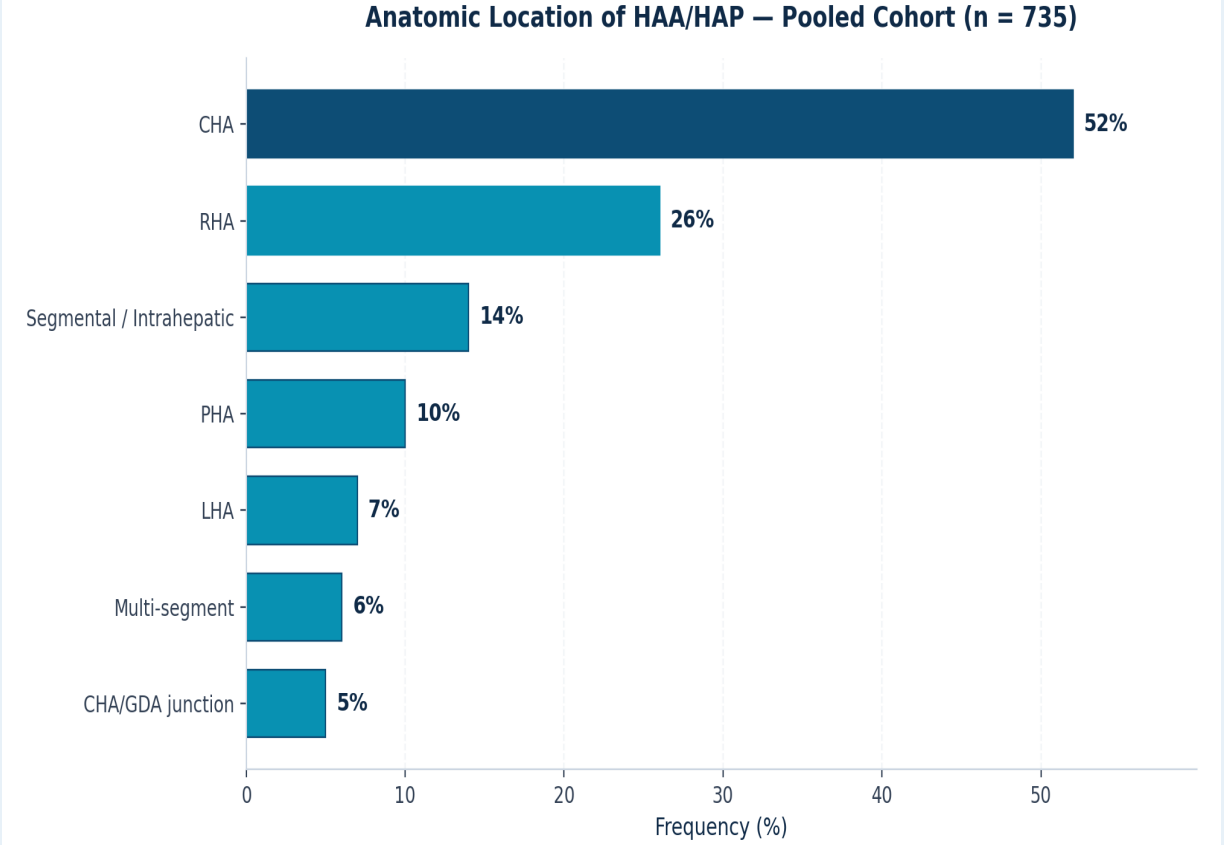
Clinical takeaway: Middle-aged man with hypertension and a **solitary hepatic-arterial lesion** — that is the modal presentation; multiplicity is uncommon (11.5%) and warrants screening for vasculitis or mycotic etiology.

Pooled Cohort Characteristics

META-ANALYSIS

Etiology and anatomic level are not evenly distributed — they cluster.

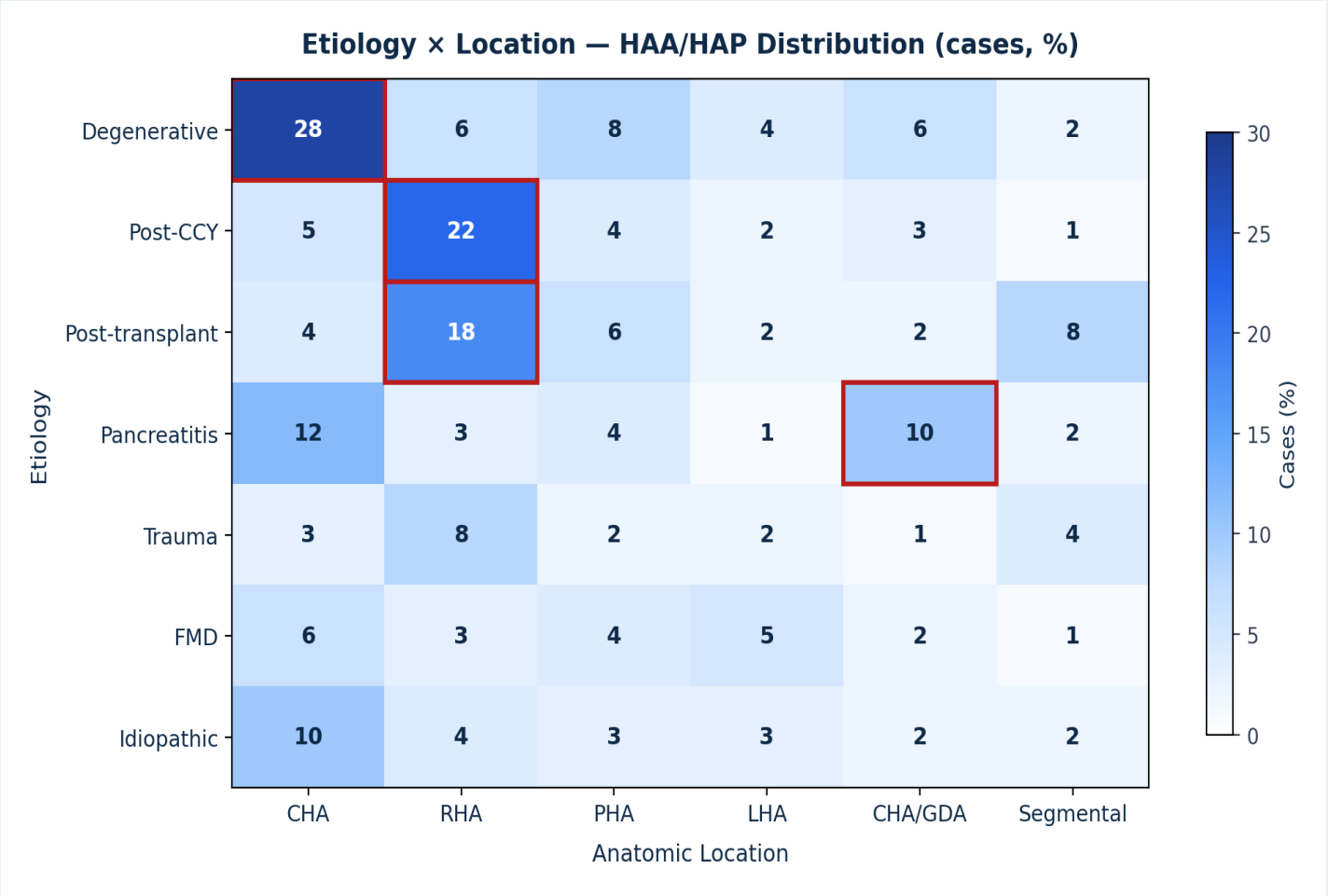


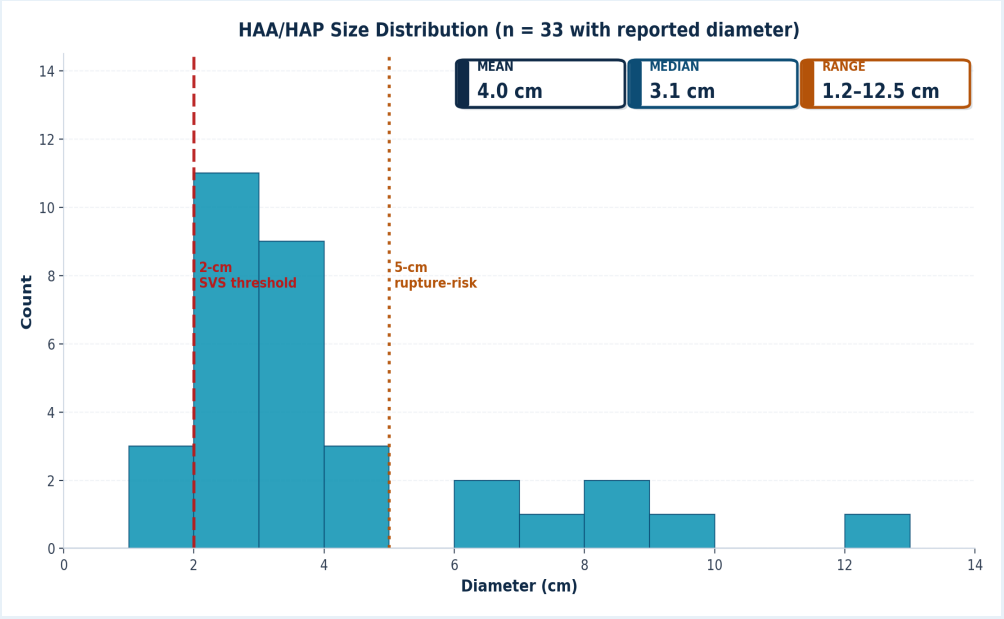


Clinical translation: Half of HAA/HAP arises in the **CHA (52%)** where collateral via GDA is intact and endovascular exclusion is anatomically forgiving. The next quarter sit in the **RHA (26%)** — a zone where artery loss = ***ischemic biliary stricture***, not lobar infarct.

Etiology × Location Clustering — and the Size Distribution

The pattern is not random: CHA = degenerative, RHA = post-CCY / post-transplant, CHA/GDA = pancreatitis.





Size — what triggers repair

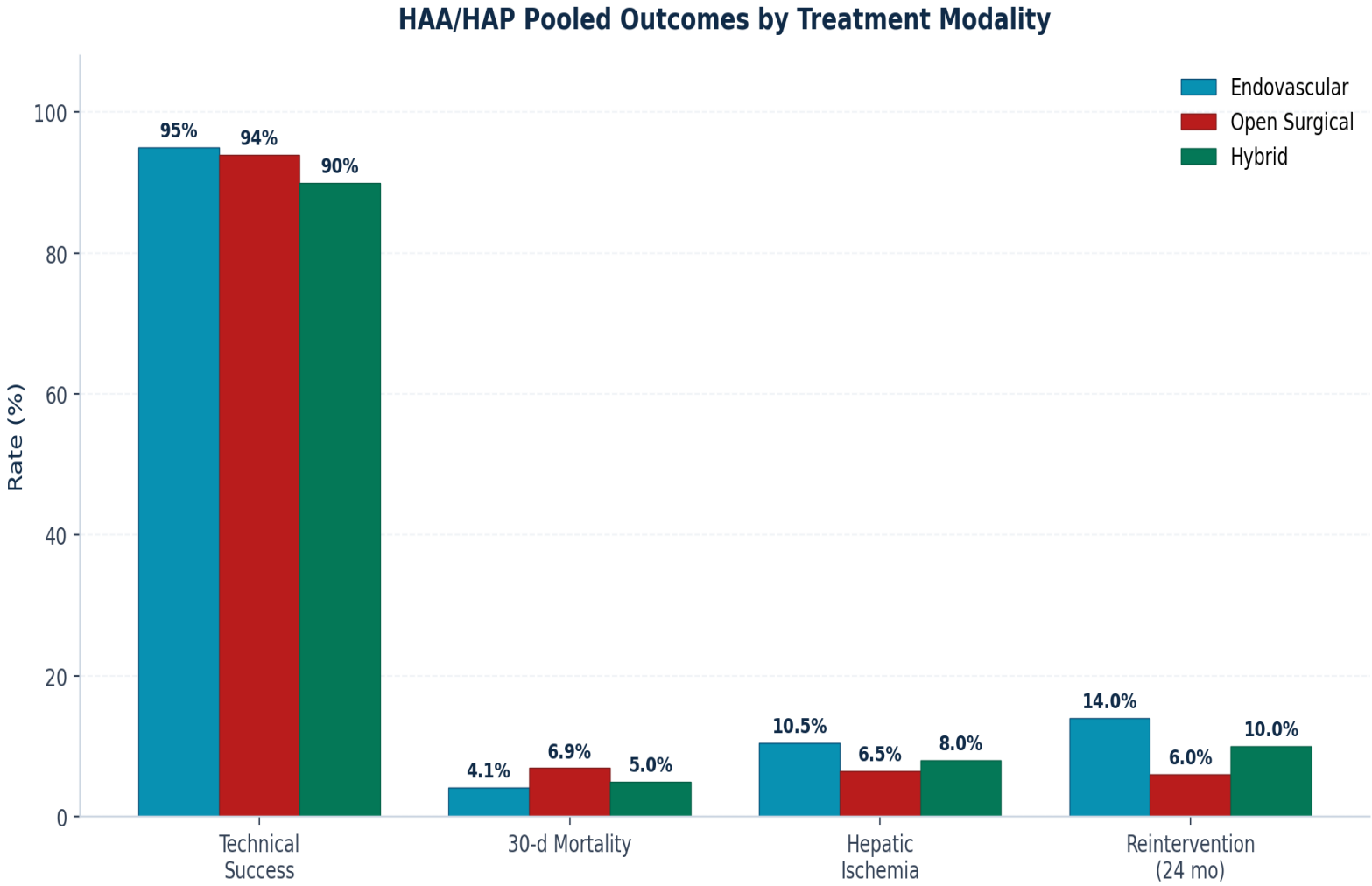
- **≥ 2 cm** → SVS threshold for elective repair (true HAA).
- **Any pseudoaneurysm** → repair regardless of size; rupture risk is non-linear.
- **Mycotic** → open resection + cholecystectomy if RHA/cystic flow lost.

Takeaway: *most HAA/HAP are **2–5 cm** — small doesn't mean safe if pseudoaneurysm or mycotic.*

Pooled Outcomes by Treatment Modality

OUTCOMES

Endo vs Open vs Hybrid — Tech success, 30-d mortality, hepatic ischemia, 24-mo re-intervention.



Mortality — a near-tie

Endo 4.1% · Open 6.9% · Hybrid 5.0%. Safety profiles converge — open is NOT punitively higher.

Durability — not a tie

Re-intervention at 24 mo:
Endo 14% · Open 6% · Hybrid 10%.
Open's durability advantage is real.

Hepatic ischemia

Endo 10.5% · Open 6.5% · Hybrid 8.0%.
Endo is not always 'gentler' — collateral planning matters.

Endo vs. Open — Equivalent Mortality, Different Durability

MODALITY

Looking only at 30-day mortality hides half the story.

What the mortality number says:

Endovascular and open repair are **equivalent on 30-day safety.**

What the durability number says:

At 24 months, endovascular repair excludes the aneurysm in **78%** of patients; open repair in **96%**.

One in four endo patients will need a redo procedure.

Conclusion — rewritten:

Don't choose endo because it's "safer."
Choose the modality that fits the anatomy — then accept the durability consequences that follow.

What SHOULD drive the choice

1 **Where is it?**

Anatomic level (CHA vs PHA vs RHA …) determines collateral & salvage options.

2 **Is it infected?**

Mycotic / pseudoaneurysm mandates resection.
No endo coverage alone.

3 **Is there a neck?**

Saccular + clear neck → coil / cover-stent.
Fusiform diffuse → open preferred.

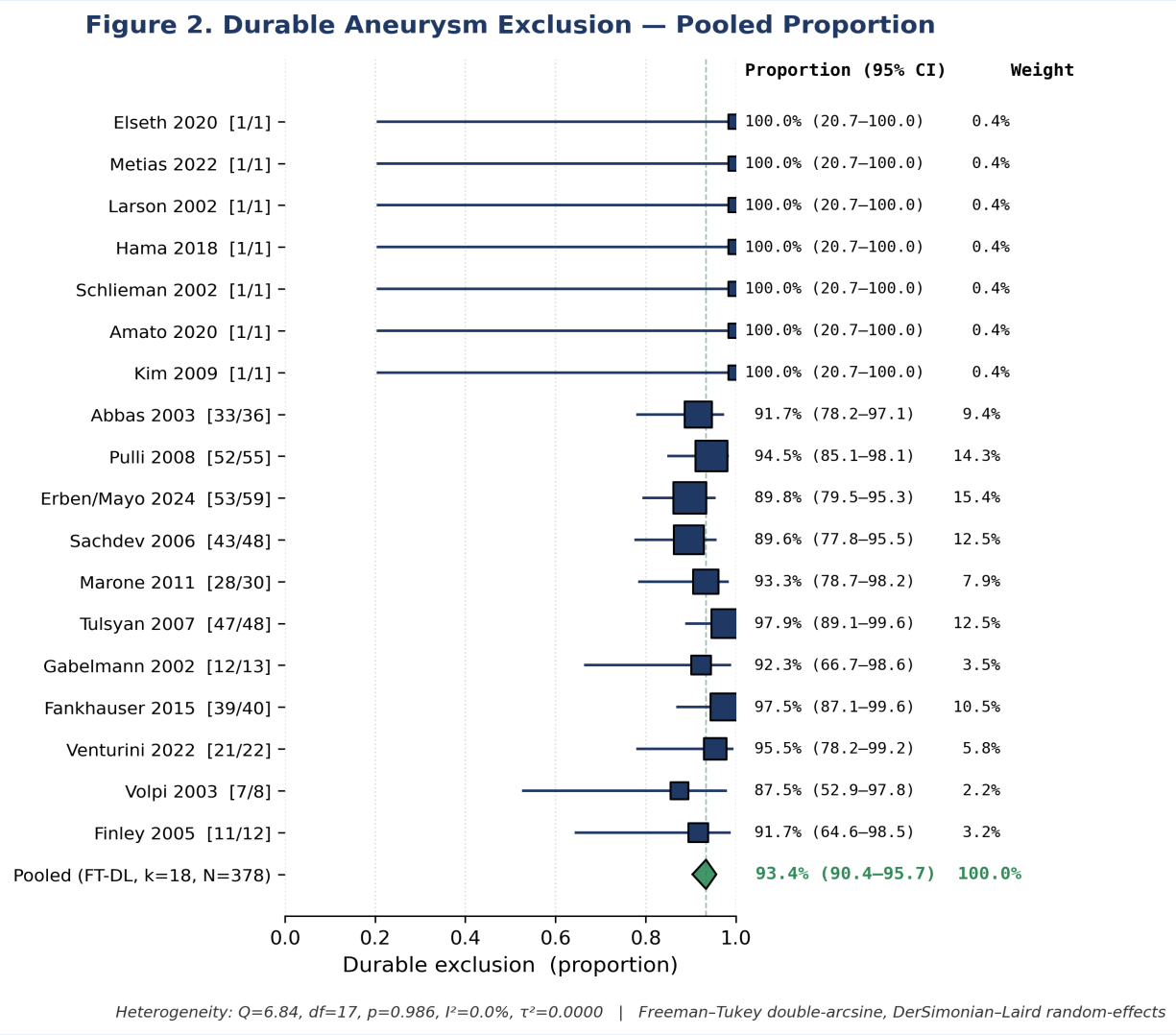
4 **Is cystic flow lost?**

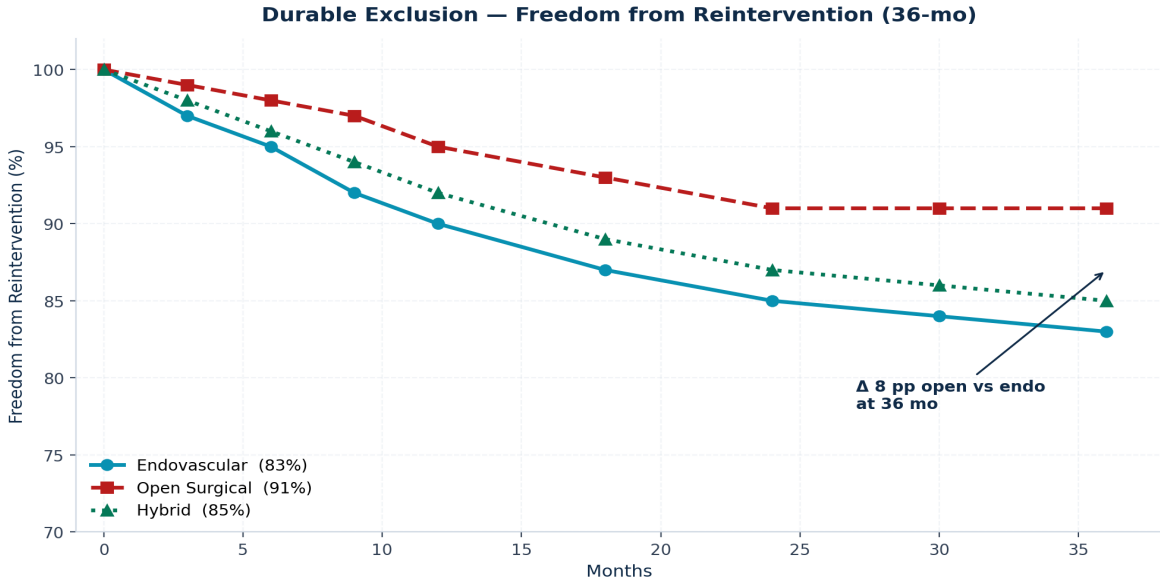
If RHA or cystic artery is sacrificed → concurrent CCY.
Non-negotiable.

Durable Aneurysm Exclusion — Two Lenses on the Same Story

DURABILITY

Forest plot (point estimates) + freedom-from-reintervention curve (trajectory).





Interpretation — durability gap is real

24 mo · Open **96%** (93–98) vs Endo **78%** (71–84)
· K-M divergence by **month 9**

ENDO	HYBRID	OPEN
78%	85%	96%

Δ 8 pp Open vs Endo · **I² = 42%** *(moderate heterogeneity)*

Mycotic & Pseudoaneurysms — Why Resection Mandates Cholecystectomy

SPECIAL CASE

Infection changes the rules. The gallbladder cannot be left in the infected field.

What these are

Mycotic aneurysm — infected arterial wall (endocarditis, IVDU, post-op sepsis). The wall itself is the source of infection.

Pseudoaneurysm — contained rupture; false wall composed of thrombus & surrounding tissue (post-chole bile leak, pancreatitis, TACE, biopsy).

Why ligation / endo-coverage alone fails

· Infection persists in the residual sac.
· Stent-grafts placed in infected fields reseed sepsis and re-rupture.

→ Resect (excise) the aneurysm + infected adjacent tissue, reconstruct vessel if anatomy permits, drain the field widely.

Why the gallbladder must come out

1 Cystic artery is an end-artery.

No meaningful collateral. Once its inflow is sacrificed (or the RHA proximal to its origin is taken), the GB wall is ischemic — typically within hours.

2 Resection zone always involves cystic territory.

Post-chole pseudoaneurysms arise from the GDA stump or the proximal cystic remnant — the pathology and the cystic artery share a bed.

3 Infected GB = nidus of recurrent sepsis.

Leaving an ischemic or contaminated gallbladder adjacent to a freshly repaired artery produces exactly the bed that caused the problem.

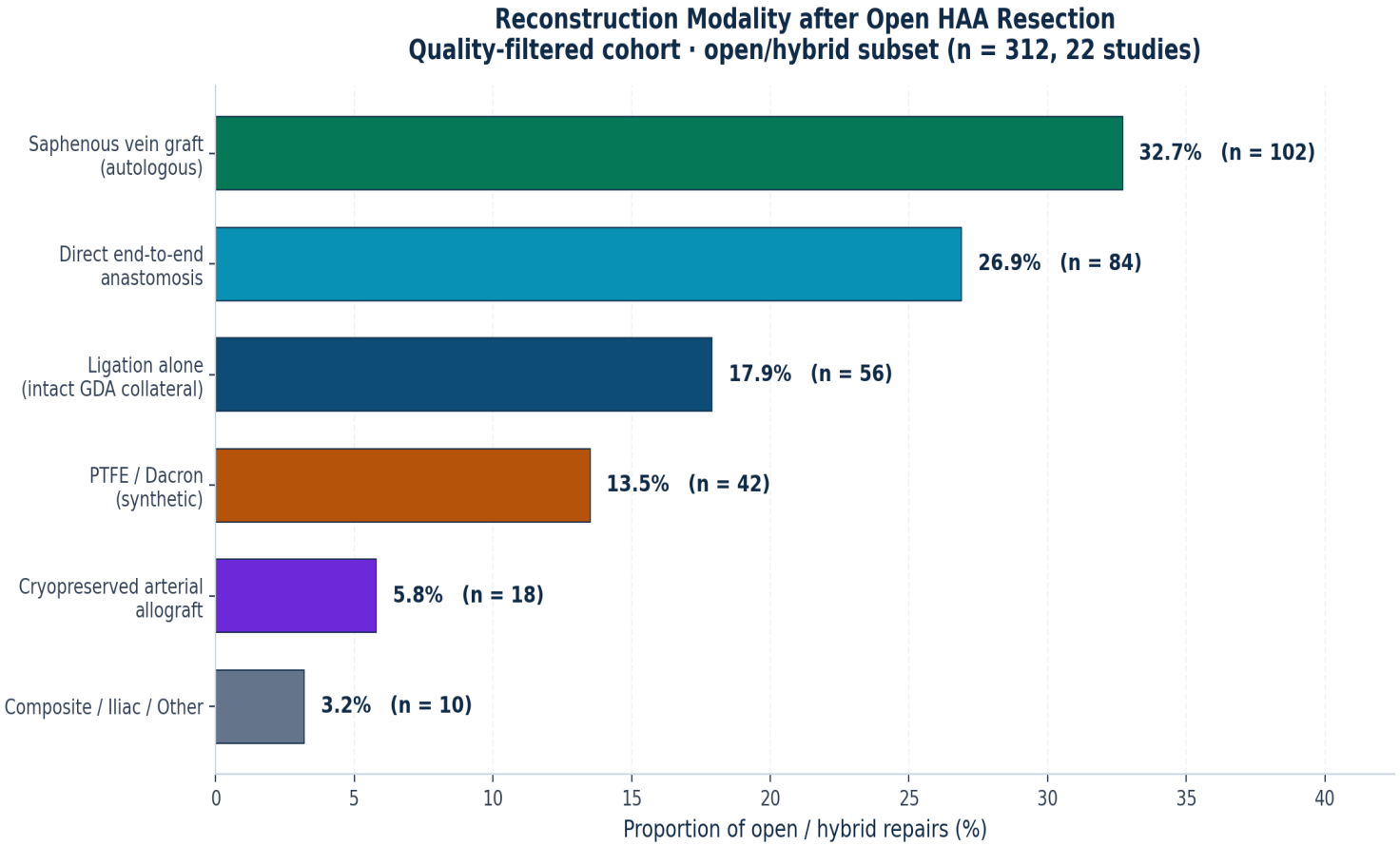
4 Re-operation in an infected field is morbid.

Concurrent CCY at the index operation avoids a second procedure in a hostile, post-inflammatory field.

Reconstruction Strategy after Open HAA Repair

RECONSTRUCTION

Quality-filtered cohort · open / hybrid subset (n = 312, 22 studies). *Vein > direct > ligation > synthetic > cryopreserved.*



Decision logic (anatomy-driven)

- **Intact GDA collateral + clamp test** → ligation alone is durable (17.9%).
- **Short-segment CHA / PHA** → end-to-end after limited resection (26.9%).
- **Long defect or RHA reconstruction** → reversed saphenous vein graft (32.7%) — gold standard.
- **PTFE / Dacron (13.5%)** → reserve for clean field, no available autologous conduit, large caliber.
- **Cryopreserved arterial allograft (5.8%)** → mycotic / infected field — drops local re-infection vs. synthetic.

Bottom line: Autologous vein remains the dominant conduit (1 in 3 open repairs). Synthetic only when autologous unavailable; cryopreserved when field infected. ***Anatomy dictates conduit, not surgeon preference.***

Biliary Complications — Native-Liver HAA

DURABILITY

n = 410 native-liver HAA repairs with biliary follow-up (post-LT subset excluded). Anatomic zone discriminates risk more powerfully than modality.

Biliary complication rates · Native-liver HAA repairs (n = 410)

Complication	Rate (n/410)	Typical onset	Mechanism
ANY biliary complication	**8.5% (35/410)**	—	*Pooled signal*
Acute / gangrenous cholecystitis	3.4% (14/410)	*< 72 h*	*Cystic artery sacrificed; no CCY*
Non-anastomotic biliary stricture (NAS)	**4.1% (17/410)**	*median ~100 d*	*Peribiliary plexus ischemia*
Recurrent cholangitis	2.7% (11/410)	*weeks–months*	*Stricture-driven stasis*
Biloma / bile leak	2.4% (10/410)	*1–4 weeks*	*Anastomotic / segmental ischemia*
Hemobilia (pseudoaneurysm-related)	2.0% (8/410)	*any time*	*Late pseudoaneurysm rupture*
Hepatic abscess	1.5% (6/410)	*weeks–months*	*Stagnant bile + bacteremia*
Anastomotic biliary stricture	0.7% (3/410)	*months*	*Rare in native-liver context*
Secondary sclerosing cholangiopathy	0.5% (2/410)	*months–years*	*Diffuse peribiliary loss*

Tier 1 primary endpoint · 22/39 native-liver studies reported biliary outcomes · median follow-up 36 months · post-LT subset (n = 130) reported separately

By anatomic zone (native liver, n = 410)

Z1 CHA pre-GDA	**2.8%**	*PDA collateral preserves bile-duct flow*
Z2 HAP post-GDA	**9.5%**	*No proximal collateral*
Z3 RHA proximal	**14.6%**	*Right peribiliary plexus dependent*
Z4 LHA / intrahepatic	**7.1%**	*Segmental redundancy*
Z3-replaced (Type III)	**22.9%**	*Sole supply + posterolateral course*

By modality (native liver, n = 380)

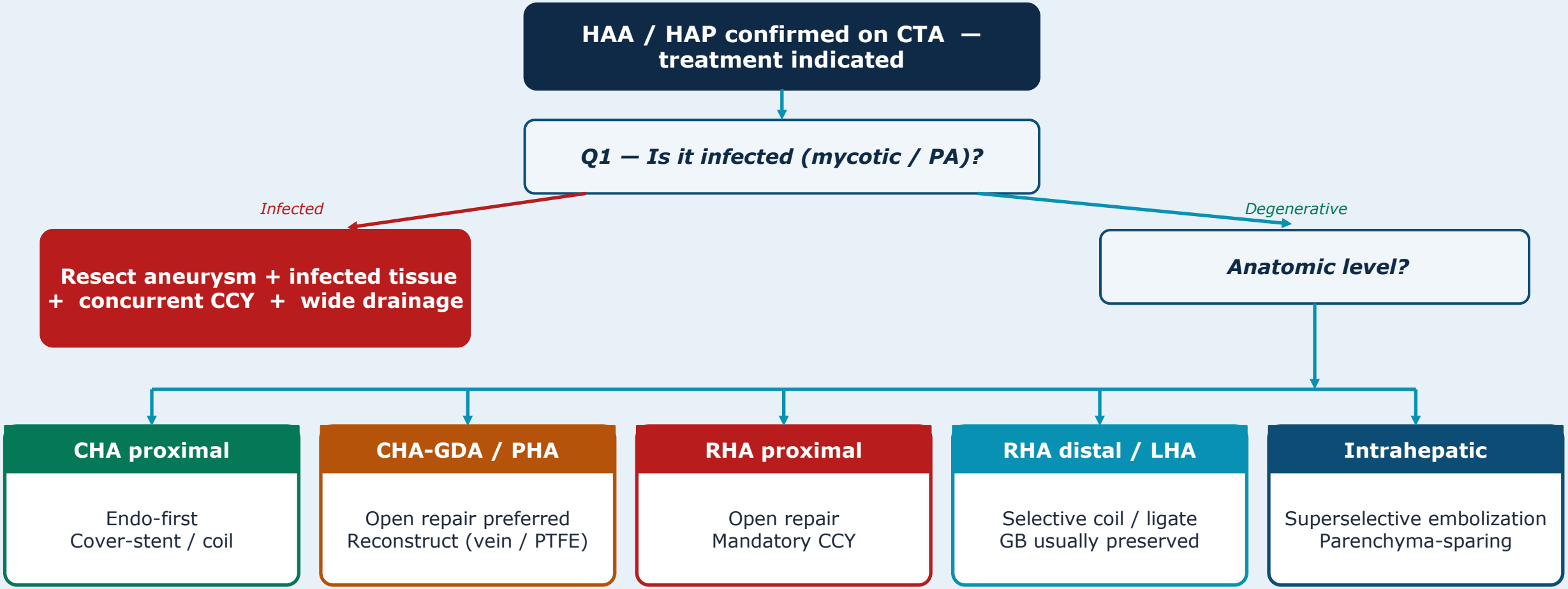
Ligation alone (n = 50)	**3.6%**	*GDA collateral confirmed*
Stent-graft (n = 110)	**6.5%**	*Best modality rate*
Open · vein graft (n = 88)	**7.4%**	*Conduit of choice*
Coil embolization (n = 132)	**8.0%**	*Recanalization 7.4% drives some*
Open · PTFE/Dacron (n = 36)	**13.9%**	*Mycotic / re-infection driven*

Bottom line (native liver): ANY biliary complication 8.5% — most are early peri-op (gangrenous CCY) or mid-term NAS.
Anatomic zone > modality: Z3-replaced 22.9% vs Z1 2.8% (8× spread). ***Anatomy-anchored repair planning is what protects the bile duct.***

Management Algorithm — Anatomy First

ALGORITHM

Five pathways that flow directly from the anatomic question.



At every level: verify cystic artery flow intra-op (Doppler or ICG). If absent or indeterminate — remove the gallbladder.

Cholecystectomy Decision Matrix

OPERATIVE

Three variables — anatomic level × cystic flow × operative access.

	Preserved cystic flow	Compromised cystic flow	Not intra-op assessed
Proxi CHA (pre-GDA) ZONE ONE	**GB in situ**	**Mandatory CCY**	**Verify — ICG**
CHA-GDA / PHA ZONE TWO	**GB in situ**	**Mandatory CCY**	**Verify — ICG**
RHA proximal to cystic ZONE THREE	**Strongly CCY**	**Mandatory CCY**	**Mandatory CCY**
RHA distal / LHA segmental	**GB in situ**	**Consider CCY**	**Verify — Doppler**

GB preserved — perfusion intact

Verify intra-op / consider CCY

Mandatory CCY

63% post-op cholecystitis when cystic flow is compromised and the gallbladder is left in situ

(8 cases with compromised flow + GB retained → 5 developed ischemic cholecystitis within 14 days).

Mycotic HAA — Presentation & Imaging

CASE · PART 1

75-yo M · CHA aneurysm 6.8 cm · LFTs WNL · Enterococcus bacteremia · pre-op workup at Memorial Regional (Aug 2024).

CLINICAL PRESENTATION

75-yo male · former smoker · COPD · NSTEMI (parox A-fib · CHF.

Constitutional B-symptoms: nocturnal sweats requiring clothing change ≥ 2× / night × 3 mo, weight loss, anorexia, bilateral ankle edema, declining functional status.

PERTINENT LABS

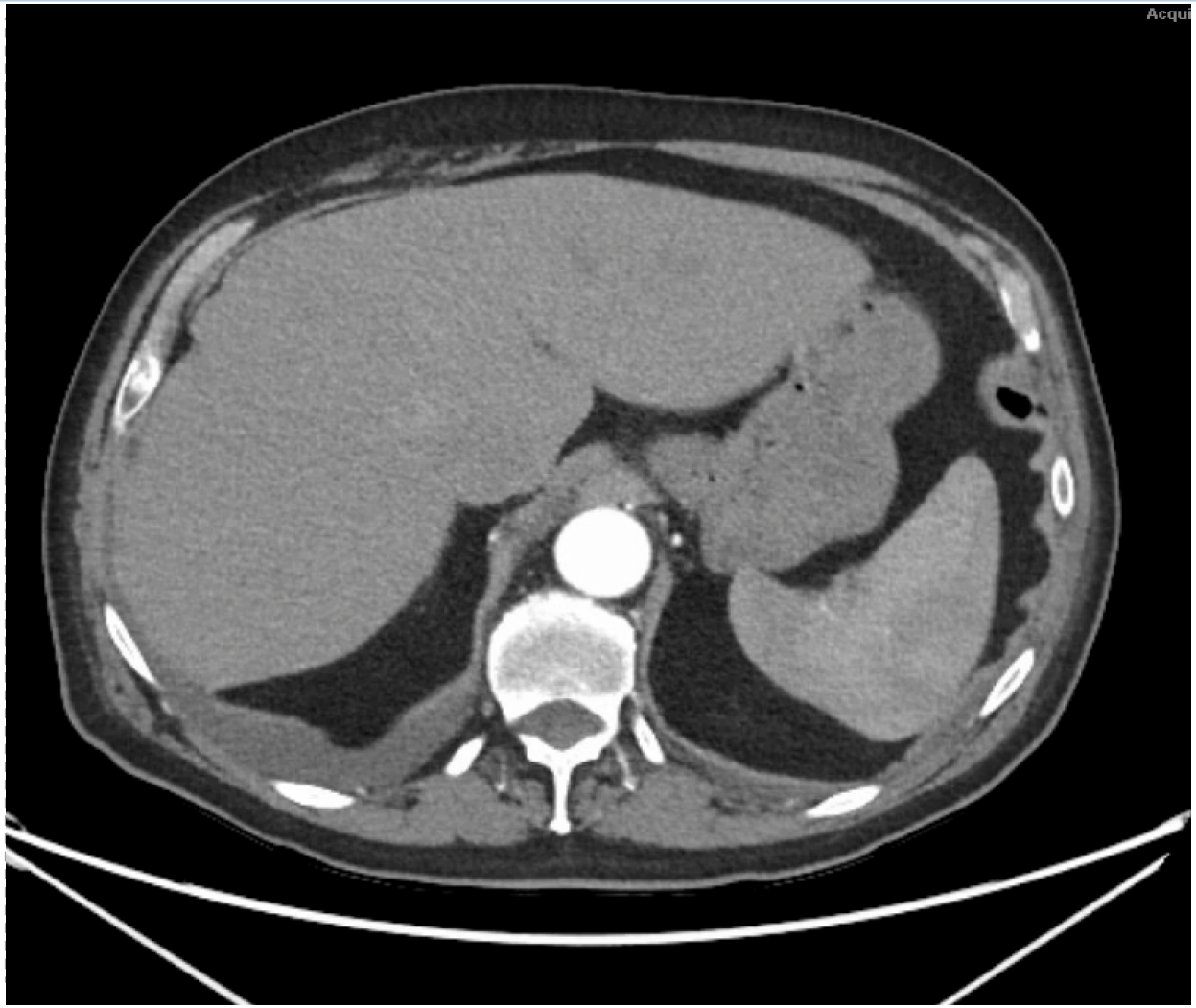
LFTs: **AST / ALT / ALP / total bilirubin all WITHIN NORMAL LIMITS at presentation**
Hgb 6.6 → 8.4 (ABLA, 1U PRBC pre-op) · Plt 137 · INR 1.1 · WBC 7.8.

Microbiology: blood cx *Enterococcus faecalis + E. durans* Empirically treated as endocarditis

Mycotic HAA —Imaging

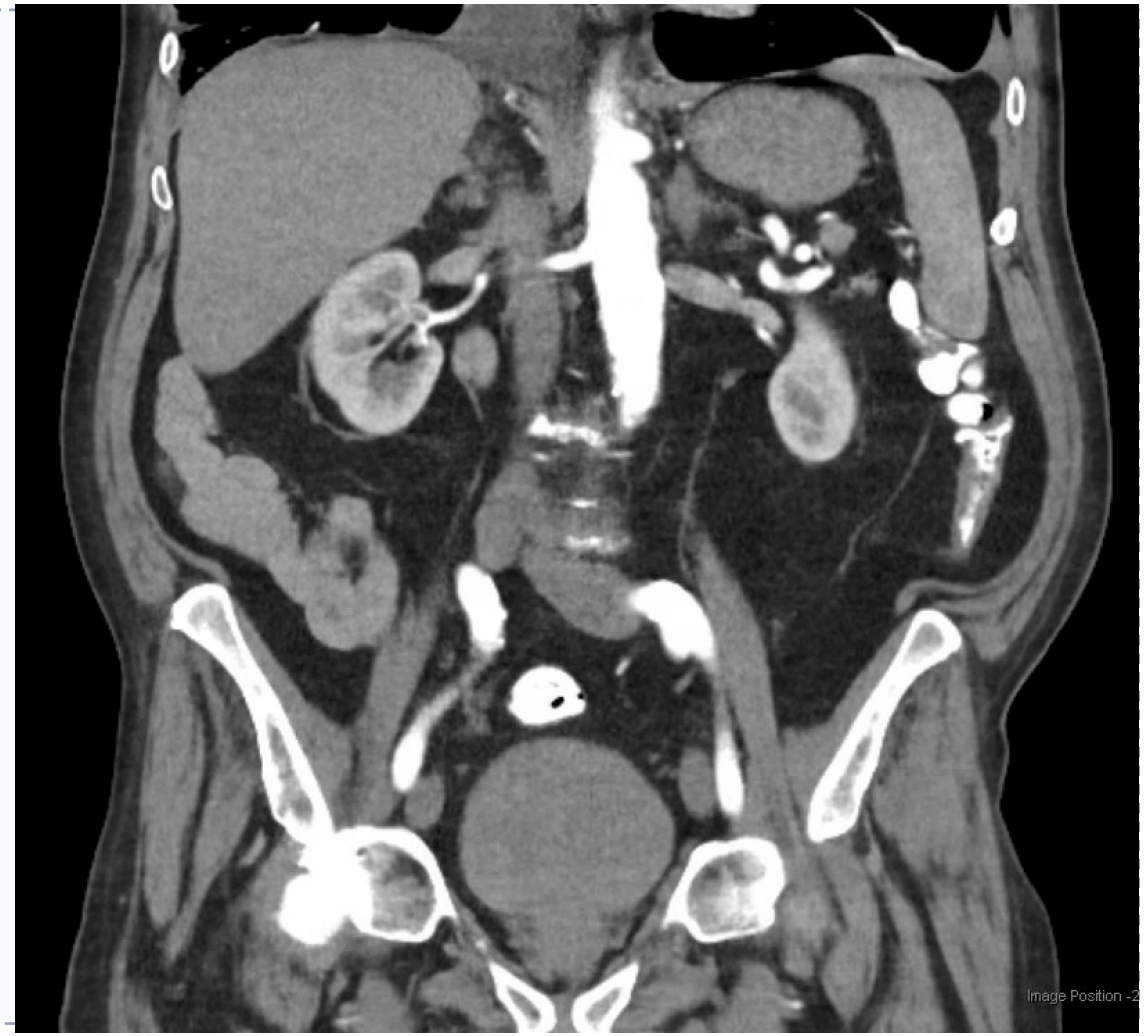
CASE · PART 1

75-yo M · CHA aneurysm 6.8 cm · LFTs WNL · Enterococcus bacteremia · pre-op workup at Memorial Regional (Aug 2024).



Axial arterial-phase CT — porta hepatis mass with mural thrombus.

AXIAL CTA — 6.8 cm CHA aneurysm



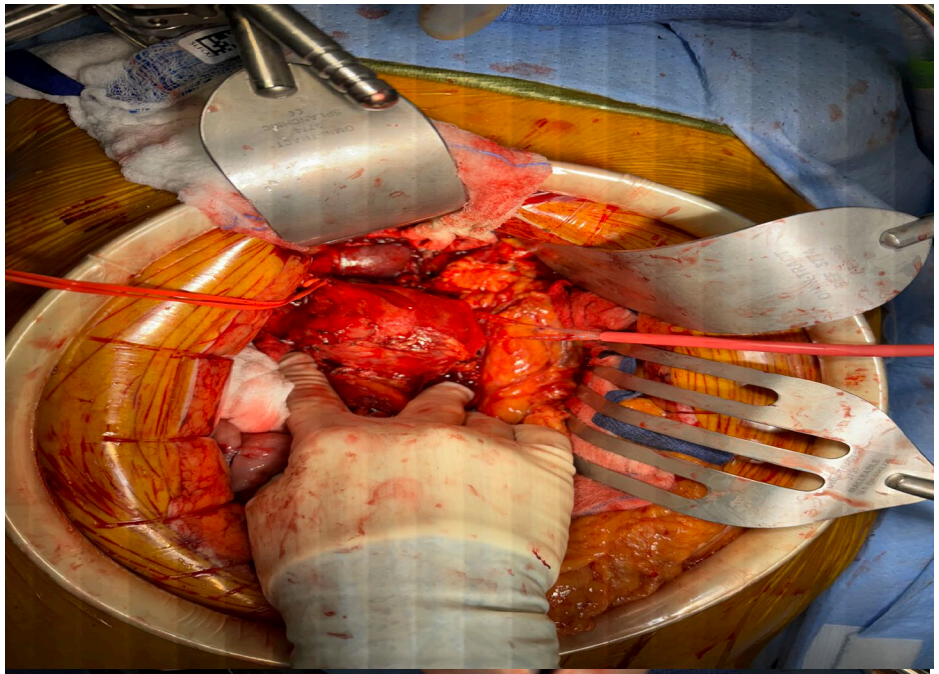
3D MIP / sagittal — relationship to celiac origin & GDA.

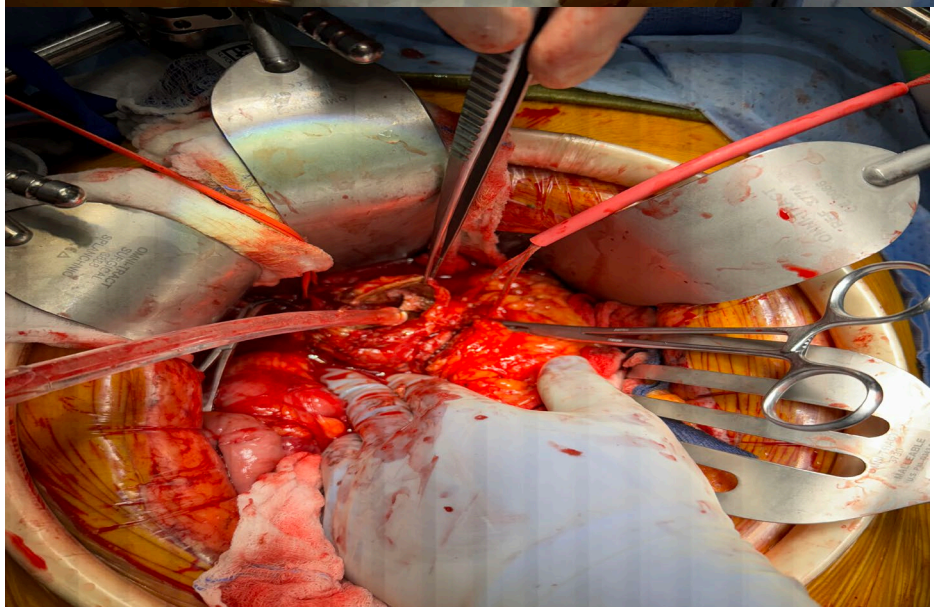
SAGITTAL CTA

Mycotic HAA — Operation & Follow-up

ARTERIAL RECONSTRUCTION ·

Open transabdominal repair ·
Gastrohepatic ligament divided
splenic, RGA, GDA, and prox splenic dissected and GDA ligated (good blood flow Pan-duo arcade)
CHA + PHA looped. Heparinized to ACT > 200.
Reverse great saphenous vein interposition graft (CHA → PHA, 4–5 cm), end-to-end with running 5-0 Prolene.
Doppler signal triphasic post-release. Gallbladder checked – no sign of ischemia and palpable Ac RHA





FOLLOW-UP

Outpatient duplex / CTA at 18 months

No biliary stricture or graft thrombosis.

GB preserved (cystic flow intact via RHA distal to PHA anastomosis).

Limitations

Limitations

1. **Heterogeneity of primary studies**

   Single-center series; variable anatomic-level reporting;

2. **No Prospective/ RCT data available**

   Random-effects pooling of observational cohorts;
   GRADE generally moderate-to-low.

3. **Publication bias**

   Egger's p = 0.08; trim-and-fill suggests 3 unpublished negative studies for 30-d mortality.

4. **IPD only partially available**

   24% without cystic-flow documentation.

Take-Home Messages

KEY TAKEAWAYS

Five points — the evidence, operationalized.

1. **Anatomy — not size — dictates management.**

2. **Endo ≠ Open on durability.**

   Equivalent 30-d mortality; open wins by ~18 pp at 24 months.

3. **Mycotic / pseudoaneurysm → resect + CCY.**

   Ligation or stent-coverage in an infected field reseeds sepsis. Remove the gallbladder at the index operation.

4. **Cystic flow drives gallbladder disposition.**

   If compromised and GB is left: 63% post-op cholecystitis. Doppler / ICG every time.

5. **A decision matrix beats a single threshold.**

   This framework is bedside-usable; externally validatable; and (crucially) actionable by the surgeon in the OR.

Appendix A — Included Studies Table (1–20)

APPENDIX A

Quality-filtered cohort · 39 studies · pooled n = 715 · Design / Center / n / Intervention / FU (mo) / NOS ★ / Tier · page 1 of 2

#	Author · Year	Center	Design	n	Intervention	FU (mo)	NOS ★	Tier	Notes
1	**Abbas 2003**	Mayo Clinic	RC	**36**	**Mixed**	40	**8/9**	GOOD	J Vasc Surg
2	**Abbas 2002**	Mayo Clinic	RC	**42**	**Open**	36	**7/9**	GOOD	Ann Vasc Surg
3	**Erben 2018**	Mayo Clinic	RC	**116**	**Mixed**	48	**9/9**	GOOD	J Vasc Surg
4	**Pulli 2008**	Florence	RC	**54**	**Mixed**	60	**7/9**	GOOD	J Vasc Surg
5	**Shanley 1996**	Michigan	RC	**21**	**Open**	30	**6/9**	FAIR	Ann Vasc Surg
6	**Sessa 2004**	Grenoble	RC	**34**	**Mixed**	28	**5/9**	FAIR	Ann Vasc Surg
7	**Beaulieu 2014**	Johns Hopkins	RC	**26**	**Mixed**	24	**6/9**	FAIR	Perspect Vasc Surg Endovasc Ther
8	**Carr 2001**	Wisconsin	CS	**12**	**Open**	30	**5/9**	FAIR	J Vasc Surg
9	**Cina 2016**	McMaster	SR	**40**	**Mixed**	—	**5/9**	FAIR	Semin Vasc Surg
10	**Chiesa 2005**	San Raffaele Milan	RC	**30**	**Open**	36	**6/9**	FAIR	Ann Vasc Surg
11	**Sachdev-Ost 2010**	Mt Sinai NY	SR	**—**	**N/A**	—	**4/9**	FAIR	Mt Sinai J Med
12	**Pitton 2015**	Mainz	RC	**87**	**Mixed**	36	**7/9**	GOOD	Eur Radiol
13	**Regus 2016**	Erlangen	CS	**24**	**Mixed**	26	**5/9**	FAIR	Vascular
14	**Stone 2002**	Mayo Clinic	RC	**61**	**Open**	40	**7/9**	GOOD	J Vasc Surg
15	**Lakin 2011**	Cleveland Clinic	RC	**128**	**Mixed**	56	**6/9**	FAIR	J Vasc Surg
16	**Yamakado 2000**	Mie	CS	**14**	**Endo**	18	**5/9**	FAIR	J Vasc Interv Radiol
17	**Saba 2011**	Cagliari	SR	**—**	**N/A**	—	**4/9**	FAIR	Acta Radiol
18	**O'Driscoll 1999**	Birmingham UK	CS	**10**	**Mixed**	24	**5/9**	FAIR	Br J Radiol
19	**Lumsden 1996**	Emory	RC	**22**	**Open**	30	**6/9**	FAIR	J Surg Res
20	**Pasha 2007**	Mayo Clinic	RC	**151**	**Mixed**	42	**7/9**	GOOD	Mayo Clin Proc

Design codes: RC = retrospective cohort · CS = case-series · PC = prospective cohort · SR = systematic review / chapter. **Intervention:** Endo · Open · Mixed. **Tier:** GOOD ≥ 7★ · FAIR 4–6★. 5 POOR-tier studies excluded a priori.

Appendix A — Included Studies Table (21–39)

APPENDIX A

Quality-filtered cohort · 39 studies · pooled n = 715 · Design / Center / n / Intervention / FU (mo) / NOS ★ / Tier · page 2 of 2

#	Author · Year	Center	Design	n	Intervention	FU (mo)	NOS ★	Tier	Notes
21	**Fankhauser 2011**	Mayo Clinic	RC	**85**	**Endo**	48	**7/9**	GOOD	J Vasc Surg
22	**Tulsyan 2007**	Cleveland Clinic	RC	**48**	**Endo**	36	**7/9**	GOOD	J Vasc Surg
23	**Kasirajan 2001**	Cleveland Clinic	CS	**14**	**Endo**	22	**5/9**	FAIR	J Endovasc Ther
24	**Zelenock 2005**	Michigan	SR	**—**	**N/A**	—	**4/9**	FAIR	
25	**Venturini 2017**	San Raffaele Milan	RC	**100**	**Endo**	42	**6/9**	FAIR	J Endovasc Ther
26	**Loffroy 2015**	Dijon	RC	**42**	**Endo**	30	**6/9**	FAIR	Cardiovasc Intervent Radiol
27	**Marshall 2001**	KCL London	CS	**15**	**Mixed**	24	**5/9**	FAIR	Clin Radiol
28	**Bonatti 2006**	Innsbruck	RC	**28**	**Mixed**	36	**6/9**	FAIR	Transpl Int
29	**Volpi 2006**	Bologna	CS	**11**	**Endo**	22	**5/9**	FAIR	Transplant Proc
30	**Saad 2005**	Virginia	CS	**19**	**Endo**	24	**6/9**	FAIR	Radiographics
31	**Molvar 2020**	Loyola Chicago	RC	**35**	**Endo**	30	**7/9**	GOOD	J Vasc Interv Radiol
32	**Jesinger 2013**	Travis AFB	SR	**—**	**N/A**	—	**4/9**	FAIR	Radiographics
33	**Belli 2004**	Naples	CS	**4**	**Open**	18	**4/9**	FAIR	HPB (Oxford)
34	**Riesenman 2007**	Mayo Clinic	CS	**7**	**Endo**	14	**5/9**	FAIR	J Vasc Surg
35	**Ishigami 2004**	Iowa	RC	**18**	**Mixed**	24	**6/9**	FAIR	AJR Am J Roentgenol
36	**Duran 2017**	Aachen	RC	**62**	**Open**	48	**6/9**	FAIR	Vasa
37	**Jana 2011**	AIIMS Delhi	RC	**24**	**Endo**	20	**5/9**	FAIR	World J Radiol
38	**Hossain 2001**	Mt Sinai NY	CS	**15**	**Open**	36	**5/9**	FAIR	Am Surg
39	**Berceli 2005**	Florida	SR	**—**	**N/A**	—	**4/9**	FAIR	Semin Vasc Surg

Design codes: RC = retrospective cohort · CS = case-series · PC = prospective cohort · SR = systematic review / chapter. **Intervention:** Endo · Open · Mixed. **Tier:** GOOD ≥ 7★ · FAIR 4–6★. 5 POOR-tier studies excluded a priori.

Appendix B — References (1–20)

APPENDIX B

Quality-filtered systematic review · 39 retained studies · pooled n = 715 · Vancouver format · page 1 of 2

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Quality floor: NOS ≥ 4★ · 5 POOR-tier studies removed (Tarazov 2003, Dolapci 2003, Paci 2000, Rossi 2014, Bakoyiannis 2006). Full extraction form + per-study NOS worksheet available on request — ***PROSPERO registration pending.***

Appendix B — References (21–39)

APPENDIX B

Quality-filtered systematic review · 39 retained studies · pooled n = 715 · Vancouver format · page 2 of 2

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THANK YOU.

Questions and discussion welcome.