Technology & Techniques To Adequately Embolize Inaccessible Small Vessels Feeding Tumors

David C. Madoff, M.D., FSIR, FACR
Professor of Radiology
Vice Chairman for Academic Affairs
@dcmadoff

Weill Cornell Medicine

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Disclosures

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Transarterial Embolotherapy
Goals

Objective:

Maximize Treatment to Tumor / Limit Non-Target Treatment = ***Successful Locoregional Therapy***

Problem:

Challenging Anatomy
- Narrow origins
- Acute angles
- Tiny vessel caliber
- Dilatated, tortuous parent vessel

→
- Prolonged procedural time
- Increased non-target embolization
- Aborted Treatment

Transarterial Embolotherapy
Historical Insights

Proximal HA devascularization → liver injury appears ***temporary*** when portal flow preserved → Preferential tumoral necrosis w/relative sparing of normal parenchyma, surgical devascularization → inoperable tumors

Early endovascular liver tumor embolization initially ***whole liver*** or ***lobar*** (limited by available tools) → Embolization techniques increasingly superselective as ***adverse events*** linked to ***non-target*** embolization

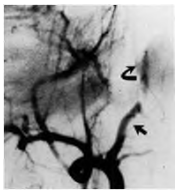
Brittain, *Am J Surg* **1964**
Almersjo, *Am J Surg* **1972**
Doyon, *Ann Radiol (Paris)* **1974**
Allison, *Lancet* **1977**
Wheeler, *Br Med J* **1979**
Yamada, *Radiology* **1983**
Chung, *Radiology* **1996**
Liapi, *Cardiovasc Intervent Radiol* **2011**

Transarterial Embolotherapy
Contributions from Interventional Neuroradiology

Neurovascular non-target embolization may be ***catastrophic***

Environment → ***innovation*** of occlusion balloon catheters

Must be ***small*** & ***compliant*** to traverse 0.5 to 1mm vessels w/o spasm or vascular complications

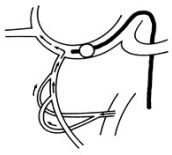


Arrow → Superficial Temporal Artery (STA) w/PSA (curved arrow)

Arrow → inflated balloon occluding STA

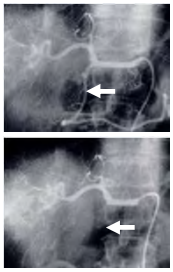
Pevsner, *AJR Am J Roentgenol* **1977**
Pevsner, *AJR Am J Roentgenol* **1980**
Moret, *J Neuroradiology* **1997**

Transarterial Embolotherapy
Occlusion Balloon Catheters in Hepatic Arterial Circulation



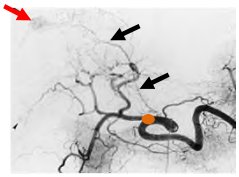
7F occlusion balloon inflated in common HA to ***reverse flow in GDA*** to avoid non-target embolization

Angiographic images → ***immediate non-filling of GDA*** after balloon inflation



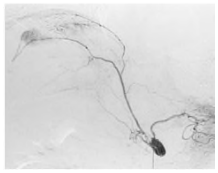
Nakamura, *Am J Roentgenol* **1985**

Transarterial Embolotherapy
Distal Balloon Technique



Tumor supplied by RIPA

Unable to cannulate on two prior attempts w/conventional techniques



5F occlusion balloon inflated just distal to RIPA origin in celiac artery & separate microcatheter placed proximal to balloon

No flow in non-target vessels (LGA coiled)
Successfully tx'd ***w/o selecting*** RIPA

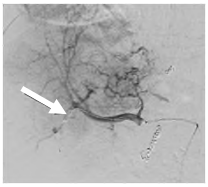
Technique utilized <u>separate punctures</u> w/4 & 5 Fr sheaths

Miyama, *Cardiovasc Intervent Radiol* **2004**

Transarterial Embolotherapy
Inverse Selective Distal Balloon Technique

Tumor w/***numerous feeding vessels*** & artery supplying ***"healthy" segment 5/6***

Technique still had considerable non-target embolization

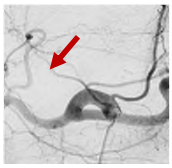


6F guide catheter in proper HA
4mm occlusion balloon microcatheter placed coaxially into non-target artery

DEB-TACE performed via proximal guide catheter

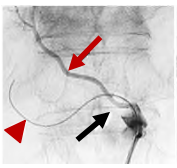
Iwagaki, *Cardiovasc Intervent Radiol* **2014**

Transarterial Embolotherapy
Balloon Blocking Technique



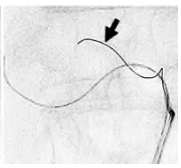
Celiac arteriogram → target RIPA

Team unable to cannulate artery for ***~70 minutes*** w/ conventional techniques



Air filled 9mm balloon just distal to RIPA origin

Wire placed through endhole of balloon catheter into HA for support



Microwire via ***2nd femoral sheath*** advanced into celiac artery

Preferentially directed into previously inaccessible artery in ***~2 minutes***

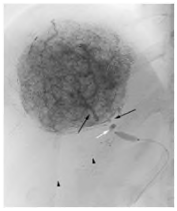
Technique utilized <u>two separate punctures</u>

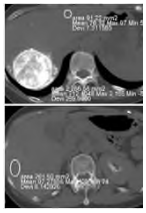
Morishita, *Cardiovasc Intervent Radiol* **2016**

Transarterial Embolotherapy
Balloon-assisted TACE (B-TACE)

Utilizes proximal occlusion balloon during superselective TACE to ***create low pressure environment***

Preliminary studies → Dense lipiodol accumulation within masses





39/42 w/dense tumor staining

Between groups, 7x denser staining of tumors w/mean stump pressure differences → 33.8 vs. 92.3 mmHg

Irie, *Cardiovasc Intervent Radiol* **2013**

Transarterial Embolotherapy
Balloon-assisted cTACE w/***<u>Adjustable Dual Balloon</u>*** Catheter

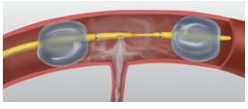
Two balloons in single 6F catheter

Balloons inflate separately w/two distinct lumens

<u>Adjustable length b/t balloons</u> to customize included area during procedure

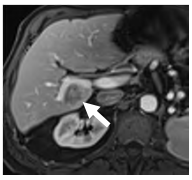
Side aperture b/t balloons → ***<u>isolated administration</u>*** of contrast &/or therapeutics

Used for cTACE – lipiodol w/ or w/o CTX easily infused

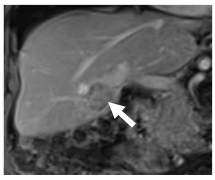


Transarterial Embolotherapy
Balloon-assisted cTACE w/***<u>Adjustable Dual Balloon</u>*** Catheter

86-yo M w/3.5 cm solitary transitional cell metastasis in s5/6 abutting Right Posterior PV



Axial MRI



Coronal MRI

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

86-yo M w/3.5 cm solitary transitional cell metastasis in s5/6 abutting Right Posterior PV

Proper Hepatic Arteriography
Tumor blush (mild hypervascularity) in s5/6 region correlates to MR findings

Transarterial Embolotherapy
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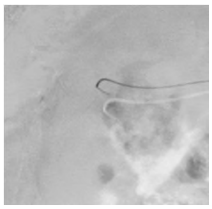

Subselective Right Hepatic Artery
Only able to catheterize one small feeding vessel

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

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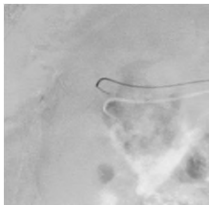

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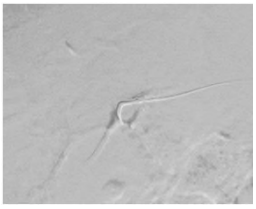

Post embolization w/1cc of 40um trisacryl gelatin microspheres, now w/resolution of tumor blush?

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

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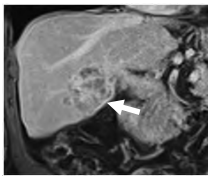

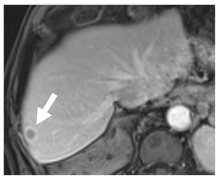

3 Month Follow Up MRI
Increased size of s5/6 mass → 5.5 cm; New cluster of sub-cm lesions in s7

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

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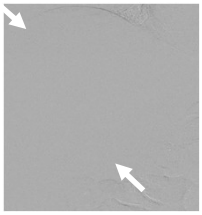


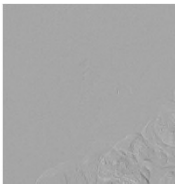
Proper Hepatic Angiogram → tumor blush in s5/6 & hepatic dome
Embolized hepatic dome tumors first

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

Numerous tiny feeding vessels
Many unselectable arteries arise from RHA

Large territory of right liver w/o tumor
Plan: limit embolization while optimizing delivery of embolic agent into tiny tumor arteries

Preferred position of occlusion balloons to maximize treatment & safety



Angiography via sidehole reveals planned tx area

Relative sparing of uninvolved liver

No reflux into LHA or GDA

Transarterial Embolotherapy
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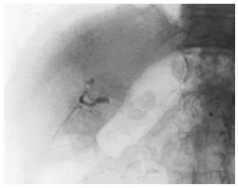

Cone Beam CT
3D visualization of treatment area w/both balloons inflated

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

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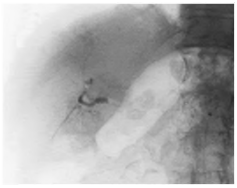

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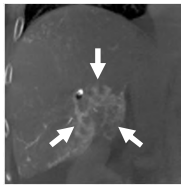

Coronal Reformat w/balloons inflated

Contrast preferentially filling target tumor

Density at hepatic dome from lipiodol embolization performed earlier

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

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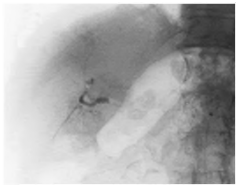

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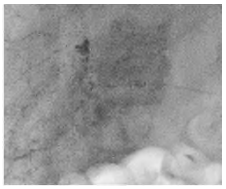


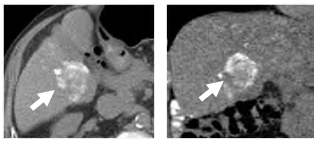
cTACE w/both balloons inflated allows ↑'d pressurization → facilitates flow of therapeutic into tiny arteries feeding tumor

Intermittent deflation of proximal balloon performed for flow control

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

86-yo M w/3.5 cm solitary transitional cell metastasis in s5/6 abutting Right Posterior PV

6 weeks Followup
Non-contrast CT → excellent lipiodol staining of tumor w/relative sparing of remaining right liver



Transarterial Embolotherapy
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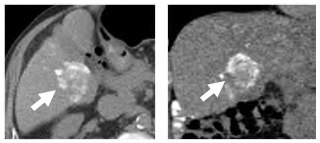
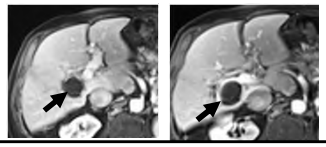
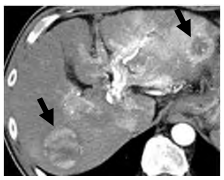


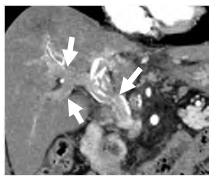
3 month Followup
Contrast-enhanced MRI – S5/6 mass w/no enhancement



Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

54-yo M w/HCC & HBV cirrhosis – ECOG PS 0, Child-Pugh – A5, MELD – 10





Bilobar metastases w/extensive infiltrative tumor in left lateral liver

PVTT throughout RPV, LPV & MPV extending to splenoportal confluence

Numerous enhancing vessels throughout tumor thrombus w/arterioportal shunting

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

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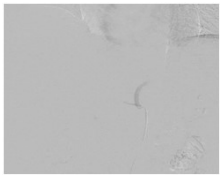
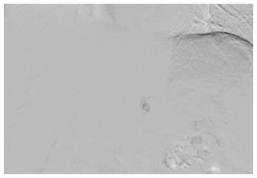


Gastrohepatic trunk w/extensive tumor staining & portal venous shunting & PVTT

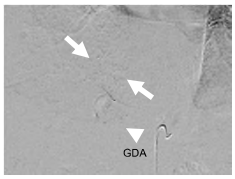


SMA & RHA arising from common trunk also feeding PVTT

1st cTACE performed with conventional microcatheter technology

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

54-yo M w/HCC & HBV cirrhosis – ECOG PS 0, Child-Pugh – A5, MELD – 10

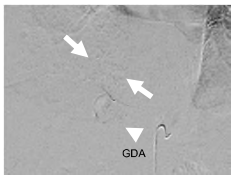


Multiple feeding vessels w/ extensive tumor blush mostly involving PV

2nd cTACE

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

54-yo M w/HCC & HBV cirrhosis – ECOG PS 0, Child-Pugh – A5, MELD – 10



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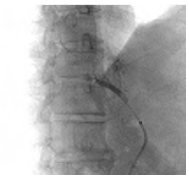
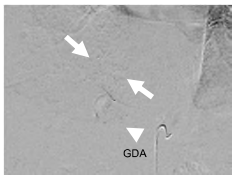


CBCT → feeding vessels w/balloons adjusted to exclude distal RHA & GDA
Treatment zone isolated

2nd cTACE

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

54-yo M w/HCC & HBV cirrhosis – ECOG PS 0, Child-Pugh – A5, MELD – 10



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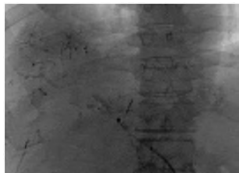

cTACE: intermittently deflating proximal balloon for forward flow & deep embolic penetration

2nd & two subsequent cTACE performed w/adjustable dual balloon catheter technology

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

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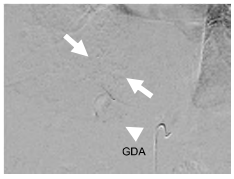
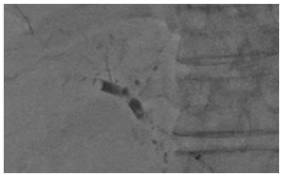


Multiple feeding vessels w/ extensive tumor blush mostly involving PV

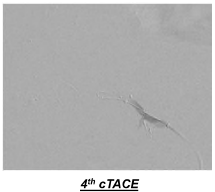


cTACE: intermittently deflating proximal balloon for forward flow & deep embolic penetration

2nd & two subsequent cTACE performed w/adjustable dual balloon catheter technology

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

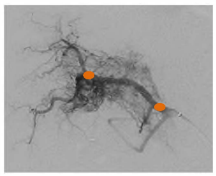
54-yo M w/HCC & HBV cirrhosis – ECOG PS 0, Child-Pugh – A5, MELD – 10



4th cTACE
Tumor thrombus predominantly fed by tiny unselectable vessels

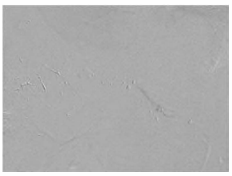
Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

54-yo M w/HCC & HBV cirrhosis – ECOG PS 0, Child-Pugh – A5, MELD – 10



4th cTACE
Tumor thrombus predominantly fed by tiny unselectable vessels

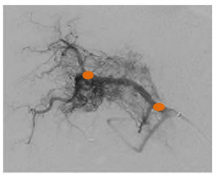
Planned placement of balloons to isolate tiny feeding branches



Angiography w/balloons up successfully excludes GDA & distal right hepatic arterial branches

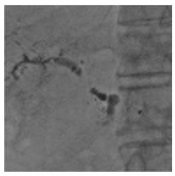
Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

54-yo M w/HCC & HBV cirrhosis – ECOG PS 0, Child-Pugh – A5, MELD – 10



4th cTACE
Tumor thrombus predominantly fed by tiny unselectable vessels

Planned placement of balloons to isolate tiny feeding branches



Repeat cTACE w/Doxorubicin 50mg in 10mL lipiodol through sidehole

Transarterial Embolotherapy
Balloon-assisted cTACE w/*Adjustable Dual Balloon* Catheter

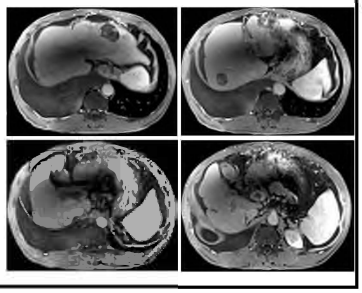
54-yo M w/HCC & HBV cirrhosis – ECOG PS 0, Child-Pugh – A5, MELD – 10

6 months later
↓ PVTT
Retracted from splenoportal confluence & ↑ portal flow

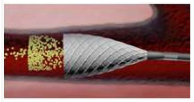
No evidence of new or other residual hepatic tumor

MELD 11
(INR 1.3 Cr 0.9 Na 135 Bili 1.6)

Child Pugh B(7)

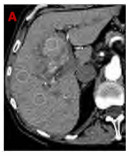


Transarterial Embolotherapy
Anti-Reflux Catheter

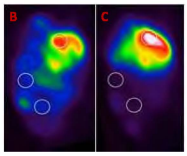


Dynamically expandable tip ***prevents reflux*** in reverse flow conditions

Preserves normal antegrade blood flow



Axial CT → target right hepatic tumor



SPECT after Tc^{99m}-MAA delivered via standard endhole catheter & anti-reflux catheter, respectively

9 patient series
24%–89% ***reduction in non-target embolization***
33%–90% ***relative increase in tumor deposition***

Pasciak, *J Vasc Interv Radiol* **2015**

Conclusion

Hepatic embolotherapy often employs superselective technique to optimize tumor treatment & limit non-target embolization

Tumors fed by small vessels may be impossible to treat w/ conventional superselective techniques → intraprocedural complications or treatment failure

Occlusion balloon & anti-reflux catheter techniques can potentially maximize therapy delivery & limit non-target embolization