Mastering polymerization time¹,²,³,⁴ for a better management of Vascular Anomalies Embolization⁵,⁶
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Vascular anomalies

- Vascular tumours and vascular malformations are common vascular anomalies characteristic for dissimilar clinical course, specific biological as well as immune cytological and histological properties.

- In 80% of cases, hemangiomas are single lesions observed dominantly on body integuments with their most common location on the head (60%), trunk (25%) and limbs (15%).

Example: Embolization of a left orbitonasal vascular malformation

Selective embolization in combination with cyanoacrylate-based glue (particularly for arteriovenous malformation or aneurysms)

Vascular anomaly embolization

Embolic vascular occlusion may be performed at any level from large arteries or veins to capillary beds, it may be temporary or permanent for treating a wide variety of conditions.

Used to treat a wide variety of conditions:

- To slow down or block blood flow
- To induce liver lobe hypertrophy

Lipiodol® indication in VAE

Lipiodol® INDICATED TO TREAT VASCULAR ANOMALY

VASCULAR ANOMALIES – FROM SIMPLE SKIN DISCOLORATIONS TO LARGE DEVASTATING DEFORMATIONS

Selective embolization in combination with cyanoacrylate-based glue (particularly for arteriovenous malformation or aneurysms)
# Vascular anomalies classification

### International Society for the Study of Vascular Anomalies (ISSVA) Classification System

**Vascular (vasoproliferative) neoplasms (tumors)**
- Infantile hemangiomia
- Congenital hemangiomias
  - RICH (rapidly involuting congenital hemangioma)
  - NICH (noninvoluting congenital hemangioma)
- Hemangioendothelioma
  - Kaposiform hemangioendothelioma and tufted angiomia
  - Spindle cell hemangioendothelioma
  - Epithelioid hemangioendotheliomas
- Other rare hemangioendotheliomas
  - Composite, retiform, and others
- Angiosarcoma
- Dermatologic acquired vascular tumors
  - Pyogenic granuloma

**Vascular malformations**
- Slow-flow vascular malformations
  - Capillary malformation
  - Venous malformation
  - Lymphatic malformation
- Fast-flow vascular malformations
  - Arterial malformation
  - Arteriovenous malformation (AVMs)
  - Arteriovenous fistula
- Combined vascular malformation
  - (various combinations of the above)

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**Lipiodol® & N-butyl cyanoacrylate glue (NBCA) endorsed by international guidelines**

- **Japanese guidelines**
  - The optimal volume, injection speed, and ratio of the NBCA-Lipiodol® mixture should be determined to facilitate successful vascular embolization. ... NBCA is radiopaque, and therefore, is usually mixed with radiopaque materials such as Lipiodol™...

- **American guidelines**
  - Cyanoacrylate glue is a liquid that may be mixed with Lipiodol®, an oily contrast medium. In Japan, it has been used during hysterosalpingography and lymphangiography. When NBCA is mixed with Lipiodol®, the NBCA becomes radiopaque, and its polymerization time is increased...

- **Consensus guidelines – International Union of Angiology**
  - NBCA is a clear free flowing adhesive liquid that will polymerize on contact with any ionic solution. NBCA must be combined with ethiodized oil to reduce the polymerization time and to add radiopacity. The more ethiodized oil used, the slower the polymerization time...

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**VASCULAR ANOMALIES ARE COMPLEX AND NUMEROUS**

**TABLES OF ISSVA CLASSIFICATION DOES NOT LIST EXHAUSTIVELY ALL VASCULAR ANOMALIES**

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**LIPIODOL® & NBCA ENDORSED BY INTERNATIONAL GUIDELINES**
**Lipiodol® mixture with cyanoacrylate (polymer) glue**

- Example of mixture

**Tools necessary to obtain Lipiodol® and NBCA (n-Butyl cyanoacrylate) mixture:**
- Three way stopcock
- Non-ionic solution (10% dextrose) to flush the catheter

**Microcatheter position**
- Close to lesion
- Far from lesion

**Catheter tip**
- Wedged
- Free

**Flow speed**
- High
- Low

**Oclusion**
- Proximal
- Distal

**Examples of applications**
- Varicocele
- Hypervascularized tumors
- Gastro-intestinal bleeding
- Peripheral bleedings
- Pseudoaneurysms
- High-flow AVM
- Organ-end artery
- Portal vein embolization
- Low-flow AVM

**Lipiodol® & NBCA dilution ratios**

<table>
<thead>
<tr>
<th>NBCA/Lipiodol® Dilution ratio 1:1 to 1:3 (10,11,12)</th>
<th>NBCA/Lipiodol® Dilution ratio 1:4 to 1:9 (11,13,14)</th>
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<tr>
<td>Microcatheter position</td>
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<tr>
<td>Close to lesion</td>
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<tr>
<td>Catheter tip</td>
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<tr>
<td>Wedged</td>
<td>Free</td>
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<td>Hypervascularized tumors</td>
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<td>Peripheral bleedings</td>
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<td>Pseudoaneurysms</td>
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<td>Portal vein embolization</td>
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<tr>
<td>Low-flow AVM</td>
<td>Low-flow AVM</td>
</tr>
</tbody>
</table>
CLINICAL APPLICATIONS

1. Portal vein embolization using a NBCA / Lipiodol® mixture before right liver resection

(a) Placement of a pigtail catheter in the main portal branch after CT-guided puncture of the left portal vein.

(b) Catheterization of a right-sided portal branch via a microcatheter system.

(c, d) Visualization of the entire embolized area of the right-sided portal branches.

Portal vein were embolized with a mixture of NBCA/Lipiodol® mean dilution ratio 1:4

LIPIODOL® & NBCA – HELPFUL FOR TRANSHEPATIC PORTAL VEIN EMBOLIZATION

« Total occlusion of the right-sided portal venous system 30 days after embolization with Histoacryl/Lipiodol®. »

« The same patient 9 months after right-sided hemihepatectomy shows a massive hypertrophy of the residual liver. »

(a) Endoscopic view of fundal varix (gastroesophageal varices type I) with active bleeding before treated with cyanoacrylate.

(b) Endoscopic view of fundal varix after cyanoacrylate therapy, showing stoppage of bleeding.

(c) Abdominal X-ray examination showing a large amount of Lipiodol®-mixed cyanoacrylate within the stomach.

(d) Computed tomography scan of thorax after Lipiodol®-diluted cyanoacrylate, showing normal pulmonary vessels.

Patients with bleeding large gastric varices - Cyanoacrylate/Lipiodol® Dilution ratio 1:1

LIPIODOL® & NBCA – FOR TREATMENT OF GASTRIC VARICES

3. Clinical efficacy of transcatheter embolization of visceral artery pseudoaneurysms using NBCA (17)

(a) 26-year-old male patient with a pseudoaneurysm in the proximal jejunum: superior mesenteric arteriography showed focal contrast media collection in the proximal jejunum, indicating a pseudoaneurysm.

(b) The microcatheter was advanced within the jejunal branch, and the pseudoaneurysm was confirmed. The 25% glue solution (histoacryl blue with Lipiodol®®) was retained and confined within the jejunal branch.

(c) After embolization, follow-up arteriography through the outer catheter confirmed a completely occluded pseudoaneurysm and preservation of the adjacent vessels.

Patient with a pseudoaneurysm in the proximal jejunum NBCA/Lipiodol® Dilution ratio 1:3

LIPIODOL® & NBCA – FOR EMBOLIZATION OF PSEUDOANEURYSMS
4. Endovascular embolization of a muscular symptomatic arteriovenous malformation (AVM) with NBCA (18)

(a) Arteriogram showing the mAVM, which is fed by multiple perforating branches of the profunda femoris artery.

(b) Embolization of the feeding branches with Glubran® 2 and Lipiodol® after selective catheterization using a microcatheter.

(c) Post-embolization arteriogram shows the occlusion of all embolized branches with complete devascularization and thrombosis of the nidus.

Patient with muscular symptomatic arteriovenous malformation
Glubran®2/Lipiodol® dilution ratio 1:2.5

LIPIODOL® & NBCA – FOR AVM TREATMENT

5. Interventional treatment of pulmonary lymphatic anomalies (19)

« [...] Percutaneous embolization of these abnormal pulmonary lymphatic vessels has been proven to be successful treatment of these conditions with minimal complication rate [...] »

(a) DCMRI of the patient with neonatal chylothorax, demonstrating abnormal pulmonary lymphatic flow toward lung parenchyma (white arrows).

(b) Fluoroscopy image of the chest again demonstrating abnormal flow of the Lipiodol® injected through groin lymph nodes toward lung parenchyma (black arrows).

Patient with neonatal chylothorax - NBCA/Lipiodol® ratio 1:2

LIPIODOL® & NBCA – FOR PULMONARY LYMPHATIC ANOMALIES
6. Infiltrated embolization of meningioma with dilute cyanoacrylate glue (20)

« [...] a 13% n-butyl-cyanoacrylate [NBCA]/Lipiodol® mixture is injected extremely slowly from the middle meningeal artery [MMA] [...] »

Patient with left convexity meningioma

LIPIODOL® & NBCA – FOR MENINGIOMA EMBOLIZATION

« [...] A 13% n-butyl-cyanoacrylate [NBCA]-Lipiodol® mixture is injected extremely slowly from the middle meningeal artery (MMA) [...] 

Contrast-enhanced MRI T1-weighted image (T1WI) revealed a left convexity meningioma with en plaque lesion (A). Left external carotid angiogram (B) showed tumor stain from MMA and STA.*

Embolization was performed via the posterior branch of the left MMA over a 15 min injection (D, E, F). White arrowhead: Microcatheter tip. H: After embolization, most of the enhanced area on contrast-enhanced T1WI disappeared (I) and changed to a necrotic area on DWI** (J).

* STA: superficial temporal artery

** DWI: diffusion-weighted magnetic resonance imaging

7. Varicocele embolization with N–butyl cyanoacrylate: experience in 41 patients (21)

« [...] The mixture with Lipiodol® also modulates the polymerization rate. We have at all times used a Lipiodol®:NBCA ratio of 1:1 [...] »

Patients with a diagnosis of varicocele - NBCA/Lipiodol® ratio 1:1

LIPIODOL® & NBCA – FOR VARICOCELE

« [...] The mixture with Lipiodol® also modulates the polymerization rate. We have at all times used a Lipiodol®:NBCA ratio of 1:1 [...] »

Color Doppler US examination. Pre-treatment (A, B) and 12 months post-embolization (C, D). At rest (A, C) and during Valsalva (B, D). Pampiniform plexus color Doppler signal during Valsalva (B) that is no longer appreciated after the embolization (D).
8. Transcatheter Embolization of a Large Symptomatic Pelvic Arteriovenous Malformation with Glubran 2 Acrylic Glue (22)

« [...] The glue needs to be mixed with lipiodol before use to enable its fluoroscopic visualization [...] »

Patient with pelvic arteriovenous malformation
Glubran 2 acrylic glue / Lipiodol® ratio 1:2.5

LIPIODOL® & GLUBRAN 2 ACRYLIC GLUE – FOR PELVIC ARTERIOVENOUS MALFORMATION

9. Emergency case – Arterial Embolotherapy for Endoscopically Unmanageable Acute Gastroduodenal Hemorrhage: Predictors of Early Rebleeding (23)

« Bleeding Dieulafoy lesion in a 76-year-old man. (A and B) Extravasation of contrast medium from the left gastric artery at the celiac trunk (arrows) and selective angiography indicates continuing bleeding. (C) After arterial microcatheterization, bleeding was controlled after embolization of the left gastric artery using a Glubran/Lipiodol® (E-Z-EM) mixture (1:3) (arrows). »

LIPIODOL® & GLUBRAN – FOR CONTROLLING BLEEDING FROM GASTRODUODENAL ULCERS
10. Emergency case – Postpartum Hemorrhage in Coagulopathic Patients: Preliminary Experience with Uterine Arterial Embolization with N-Butyl Cyanoacrylate (24)

Images of primary PPH caused by uterine atony after caesarean section in a 33-year-old woman. (a) Right internal iliac arteriogram shows a beaded, dilated ascending branch of the uterine artery (arrow). (b) Delayed phase right internal iliac arteriogram shows contrast agent extravasation (arrow) in the uterine body. (c) Right internal iliac arteriogram obtained immediately after UAE with 1.5 blocks of gelatin sponge particles (arrow) indicates the disappearance of extravasation. (d) Right internal iliac arteriogram obtained immediately after UAE with 1.5 blocks of gelatin sponge particles (arrow) indicates the disappearance of extravasation. (e) Right internal iliac arteriogram obtained immediately after embolization of the ascending branch of the right uterine artery with a 0.5 mL bolus of a 1:1 mixture of NBCA and Lipiodol® shows retained Lipiodol® (arrow) and no extravasation.

LIPIODOL® & NBCA – FOR EMERGENT POSTPARTUM HEMORRHAGE

**Features**
- Immediate anomaly visualization & localization for real-time procedure guiding (11,21)
- Per-procedure complete anomaly filling visual confirmation (11,16,24)
- Radiopacity & increased polymerization time thanks to Lipiodol® & NBCA mixture (3,2,24)
- Modification of polymerization time according to the Lipiodol® & glue ratio (1,10,11,23,24)

**Benefits**
- Visualizer
- Vectorizer & Timer
LIPIODOL® ULTRA-FLUID. Composition: Ethyl esters of iodized fatty acids of poppy seed oil at 6 mL corresponding to an iodine content of 450 mg/mL. Indications (**): A diagnostic radiology - Hysterosalpingography - Ascending urethrography - Lymphography - Sialography - Fistulography and exploration of abscesses - Exploration of frontal sinuses - Pre and post-operative cholangiography.

Effects on ability to drive and to use machines: The effects on ability to drive and to use machines have not been investigated - Visualisation and localization (by selective intra-arterial use during CT) of liver lesions in adults with known or suspected hepatocellular carcinoma - Visualisation, localisation, and embolisation of tumours in the lungs, liver, mesentery, and brain.

Contraindications: - Hysterectomy - Intra-arterial injection of LIPIODOL ULTRA-FLUID in patients with known or suspected allergy to iodinated contrast agents, bronchial asthma or allergic disorders because of an increased risk of a hypersensitivity reaction to LIPIODOL ULTRA-FLUID.

Special precautions for use (*):

**Indications, volumes and presentations may differ from country to country.** (*) For complete information please refer to the local Summary of Product Characteristics (SPC). **(Trans-Arterial Chemo-Embolization of hepatocellular carcinoma at intermediate stages, in adults: Selective embolization in combination with histology or radiotherapy (particularly for arterio-portal shunting in macroscopic arterial branch). Selective embolization of LIPIODOL ULTRA-FLUID into the hepatic artery for diagnostic purposes when a spiral CT is not possible. Procedure in case of severe cases of idiopathic dolichemia: Pometry and method of administration (**): How to be adapted according to the type of examination, the territories explored the weight and the age of the patient. The choice of whether to embolization depend on the particulate responsivness of the tissues and the size of the patient.

**Corresponding author:** Ebrahimi, E. 

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