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Title: Standardized Approach to Superior Mesenteric Artery Resection for Locally Advanced Pancreatic Cancer

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Author Questionnaire

1. **Microscopy**: Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or something similar? **No**

2. **Software:** Does the part of your protocol being filmed include step-by-step descriptions of software usage? **No**

3. **Filming location:** Will the filming need to take place in multiple locations? **No**

Current Protocol Length
Number of Steps: 23
Number of Shots: 49

Introduction

Videographer: Obtain headshots for all authors available at the filming location.

1.1. **Carl Leonhardt:** We are conducting research in the field of pancreatic cancer and pancreatic surgery in general. We are trying to understand how to fit the most appropriate treatment to each patient. To answer this, we are using clinical data as well as translational approaches in the laboratory.

1.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 2.3.1*

What are the most recent developments in your field of research?

1.2. **Carl Leonhardt:** The most important development in the field of pancreatic cancer surgery was the advent of effective multimodal neoadjuvant treatment options. Thanks to this development, patients who were considered unresectable can now be resected in selected cases of exceptional response.

1.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 3.2.1*

What research gap are you addressing with your protocol?

1.3. **Carl Leonhardt:** Arterial resections in pancreatic cancer surgery are only carried out by a few expert centers globally and are poorly described and standardized. With this protocol we aim to improve standardized approaches for these complex procedures as well as encourage future technical refinements.

1.3.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 5.1.2*

Videographer: Obtain headshots for all authors available at the filming location.

Ethics Title Card

This research has been approved by the Institutional Review Board (IRB) at Medical University of Vienna

Protocol

Videographer's NOTE: It was not possible to do classical board slating, but we tried our best to audio announce. As the angle for this operation was really difficult to film, I have recorded crucial steps from different angles at the same time

2. Incision and Exploration Phase

Demonstrator: Oliver Strobel

2.1. To begin, perform a median laparotomy extending from the xiphoid process to a point below the umbilicus to ensure adequate exposure of the critical anatomical structures **[1]**. Using surgical instruments, carefully preserve the falciform ligament to later use it as a cover for the arterial anastomosis **[2]**.

2.1.1. WIDE: Talent performing a midline incision from the xiphoid to below the umbilicus using a scalpel.

2.1.2. Shot of the preserved falciform ligament.

2.2. Then, elevate the omentum and the transverse colon cranially to improve access to the mesenteric root **[1]**. Make an oblique incision approximately 10 centimeters in length below the mesocolon, extending from the ligament of Treitz to the right mesocolon, to expose the superior mesenteric artery and vein **[2]**.

2.2.1. Talent lifting the omentum and transverse colon upwards using forceps.

2.2.2. Talent performing an oblique incision below the mesocolon with electrocautery, exposing the superior mesenteric artery and vein.

NOTE: Show step 2.4 after 2.2

2.3. Using ligatures and clips, dissect the mesenteric fatty and lymphatic tissue to ligate small blood and lymphatic vessels **[1]**. Continue the dissection until the superior mesenteric artery is fully exposed and secure it with a vessel loop **[2]**. Excise a sample from the nerve plexus surrounding the superior mesenteric artery and send it for frozen section analysis **[3]**.

2.3.1. Talent placing ligatures and applying clips on mesenteric vessels during dissection.

2.3.2. Talent looping a vessel loop around the exposed superior mesenteric artery.

2.3.3. Talent removing a tissue specimen from the nerve plexus and placing it into a

container.

NOTE: Show step 2.4 after 2.2

2.4. Next, expose the superior mesenteric vein and its branches to assess the potential for venous reconstruction **[1]**. Identify one of the main branches of the superior mesenteric vein to confirm its adequacy for venous reconstruction and intestinal drainage **[2]**. Evaluate the portal vein in the hepatoduodenal ligament to determine its suitability for reconstruction **[3]**.

2.4.1. Talent dissecting and exposing the superior mesenteric vein and its branches.

2.4.2. Talent pointing to a main branch of the superior mesenteric vein.

2.4.3. Talent pointing to the portal vein within the hepatoduodenal ligament.

3. Resection Phase

3.1. After confirming that reconstruction of the superior mesenteric artery and vein is feasible, enter the lesser sac **[1]**. Perform an extended Kocher maneuver to mobilize the duodenum and expose the left renal vein **[2]**. Proceed with a right-sided artery-first approach to access the proximal segment of the superior mesenteric artery at its origin from the aorta **[3]**.

3.1.1. Talent opening the lesser sac.

3.1.2. Talent performing a Kocher maneuver to reflect the duodenum and reveal the left renal vein.

3.1.3. Talent exposing the proximal superior mesenteric artery from the right side.

3.2. Now, transect the superior mesenteric plexus near the origin of the superior mesenteric artery using dissecting instruments **[1]**. Collect a tissue specimen and send it for frozen section analysis **[2]**.

3.2.1. Talent transecting the plexus tissue around the superior mesenteric artery.

3.2.2. Talent placing the excised tissue into a labeled container.

3.3. To proceed with the resection, perform a cholecystectomy using appropriate surgical tools and dissect the hepatoduodenal ligament to continue exposure of critical structures **[1]**. **NOTE**: VO merged for the deleted shot

3.3.1. ~~Talent removing the gallbladder with electrocautery~~.

3.3.2. Talent dissecting the hepatoduodenal ligament using blunt and sharp techniques.

3.4. Perform a lymphadenectomy of lymph nodes 8, 9, and 12 along the hepatic artery and the celiac artery **[1]**. Use bipolar forceps, monopolar electrocautery, or vessel sealing devices to ensure hemostasis and safe dissection **[2]**.

3.4.1. Talent isolating and excising lymph nodes along the hepatic and celiac arteries.

3.4.2. Talent using electrocautery and vessel sealing devices to stop blood flow.

3.5. Secure the common hepatic artery and the celiac trunk with vessel loops **[1]**. Then, divide the common bile duct and place a vessel loop around the portal vein to secure it **[2]**.

3.5.1. Talent looping vessel ties around the common hepatic artery and the celiac trunk.

3.5.2. Talent cutting the common bile duct and securing the portal vein with a vessel loop.

3.6. Ligate the right gastric artery, the gastroduodenal artery, and the right gastroepiploic artery **[1]**. Use a linear stapler to transect either the postpyloric duodenum or the prepyloric antrum based on the tumor location **[2]**.

3.6.1. Talent ligating the listed arteries with clips and sutures.

3.6.2. Talent using a stapler to divide the duodenum or antrum as appropriate.

3.7. Next, place the remnant stomach into the upper left quadrant of the abdominal cavity to improve visibility of the superior pancreatic margin **[1]**.

3.7.1. Talent repositioning the stomach with forceps toward the upper left quadrant.

3.8. Transect the transverse mesocolon, including the middle colic vessels, below the marginal vessels until reaching the left of the ligament of Treitz **[1]**.

3.8.1. Talent transecting the mesocolon and middle colic vessels using electrocautery.

3.9. Then, transect the second jejunal loop and excise the associated mesentery, including both the first and second jejunal branches **[1]**.

3.9.1. Talent dividing the second jejunal loop and mesentery using scissors and electrocautery.

3.10. Completely divide the mesenteric tissue on the left of the superior mesenteric artery from the looped segment to the ligament of Treitz **[1]**. Clip or ligate all tributaries, including arterial, venous, and lymphatic vessels during the dissection **[2]**.

3.10.1. Talent dissecting and separating mesenteric tissue beside the superior mesenteric artery.

3.10.2. Talent applying clips and ligatures on all visible vessels and lymphatics.

3.11. Next, dissect the lower pancreatic margin to access the pancreatic neck **[1]**. Tunnel the pancreatic neck and use a scalpel to divide the pancreas **[2]**. Submit the transection margin for frozen section analysis **[3]**. Then, identify the splenic vein and secure it with a vessel loop **[4]**.

3.11.1. Talent dissecting the lower margin of the pancreas using fine instruments.

3.11.2. Talent creating a tunnel under the pancreatic neck and cutting the pancreas with a scalpel.

3.11.3. Talent placing the cut margin into a labeled container for frozen section.

3.11.4. Talent looping the splenic vein.

3.12. After looping the splenic artery using blunt dissection and vessel loops **[1]**, perform a lymphadenectomy along the splenic artery at the superior border of the pancreas **[2]**.

3.12.1. Talent looping the splenic artery near the pancreatic upper margin.

3.12.2. Talent dissecting lymph nodes along the splenic artery using bipolar forceps.

3.13. Now, using sharp dissection and sealing devices, completely dissect all soft tissue between the celiac trunk and the superior mesenteric artery **[1]**.

3.13.1. Talent removing tissue between the celiac trunk and superior mesenteric artery.

4. Vascular Resection and Reconstruction

4.1. To perform a Cattell-Braasch maneuver, mobilize the small bowel, mesentery, and right-sided hemicolon **[1]**. Then, clamp the superior mesenteric artery both close to its aortic origin and distal to the tumor mass **[2]**.

4.1.1. Talent mobilizing the bowel and mesentery during the Cattell-Braasch

maneuver.

4.1.2. Talent applying vascular clamps at two points along the superior mesenteric artery.

4.2. Clamp the superior mesenteric vein in the mesentery and also clamp the portal vein **[1-TXT]**.

4.2.1. Talent placing clamps on the superior mesenteric vein and portal vein. **TXT: Skip this step if cavernous transformation and a mesenterico-portal shunt are present; In this case, a ringed prosthesis was used (12 mm diameter and 30 cm length)**

4.3. Transect the clamped vein and perform a venous anastomosis using non-resorbable monofilament 6-0 *(6-oh)* running sutures, incorporating a growth factor to prevent narrowing **[1]**. In case of diameter mismatch, release the superior mesenteric vein inflow before knotting the suture to allow proper expansion of the anastomosis **[2]**.

4.3.1. Talent cutting the vein between clamps and starting venous anastomosis with running sutures.

4.3.2. Talent releasing SMV inflow to allow vein to distend before final knotting.

4.4. Next, reconstruct the superior mesenteric artery using an end-to-end anastomosis with non-resorbable monofilament 6-0 sutures **[1]**. For the posterior wall, use a parachute technique **[2]**. Complete the anterior wall anastomosis with either interrupted or running sutures **[3]**.

4.4.1. Talent aligning artery ends for end-to-end anastomosis.

4.4.2. Talent performing a parachute suture on the posterior arterial wall.

4.4.3. Talent completing anterior wall anastomosis with chosen suture technique.

4.5. Release the venous clamp to restore blood flow through the reconstructed vein **[1]** and then release the arterial clamp to re-establish arterial circulation **[2]**.

4.5.1. Talent removing the venous clamp while checking for bleeding.

4.5.2. Talent removing the arterial clamp and inspecting the anastomosis.

4.6. Finally, wrap the arterial anastomosis using a falciform ligament patch or an omental

flap to shield it from pancreatic secretions **[1]**. Place a Robinson drain behind the vascular anastomoses **[2]** and insert two Easy-Flow drains at the sites of the hepaticojejunostomy and pancreaticojejunostomy **[3]**.

4.6.1. Talent covering the arterial anastomosis with falciform or omental tissue.

4.6.2. Talent inserting a Robinson drain posterior to the vascular repairs.

4.6.3. Talent positioning Easy-Flow drains at both anastomotic sites.

Results

5. Results

5.1. Pre-operative triple-phase computed tomography in axial and coronal planes showed encasement of the superior mesenteric artery **[1]** and identified the first jejunal branch in close proximity **[2]**.

5.1.1. LAB MEDIA: Figure 1A. *Video editor: Highlight the short white arrow pointing to a circular structure*.

5.1.2. LAB MEDIA: Figure 1B. *Video editor: Highlight the long black arrow pointing diagonally at a tubular structure*.

5.2. Intraoperative imaging revealed the reconstructed vascular anatomy with clear identification of the superior mesenteric artery anastomosis **[1]** and the superior mesenteric vein anastomosis **[2]**.

5.2.1. LAB MEDIA: Figure 2. *Video editor: Highlight the area marked with a black arrow on the left side*.

5.2.2. LAB MEDIA: Figure 2. *Video editor: Highlight the area marked with a white arrow*

- **xiphoid**

Pronunciation link:
https://www.merriam-webster.com/dictionary/xiphoid
IPA: /ˈzɪfɔɪd/
Phonetic Spelling: zis-foid

- **falciform**

Pronunciation link:
https://www.merriam-webster.com/dictionary/falciform
IPA: /ˈfæl səˌfɔrm/
Phonetic Spelling: fal-suh-form

- **omentum**

Pronunciation link:
https://www.merriam-webster.com/dictionary/omentum
IPA: /oʊˈmɛntəm/
Phonetic Spelling: oh-men-tum

- **mesocolon**

Pronunciation link:
https://www.howtopronounce.com/mesocolon
IPA: /ˌmɛsəˈkoʊlɒn/ (American: /ˌmɛsəˈkoʊlɑn/)
Phonetic Spelling: mes-uh-koh-lon

- **ligament**

Pronunciation link:
https://www.merriam-webster.com/dictionary/ligament
IPA: /ˈlɪgəmənt/
Phonetic Spelling: lig-uh-ment

- **ligature**

Pronunciation link:
https://www.merriam-webster.com/dictionary/ligature
IPA: /ˈlɪgətʃər/
Phonetic Spelling: lig-uh-chur

- **anastomosis**

Pronunciation link:
https://www.merriam-webster.com/dictionary/anastomosis
IPA: /ˌænəˈstomoʊsɪs/
Phonetic Spelling: an-uh-sto-moh-sis

- **Kocher**

Pronunciation link:
https://www.merriam-webster.com/dictionary/Kocher
IPA: /ˈkoʊkər/
Phonetic Spelling: koh-ker

- **lymphadenectomy**

Pronunciation link:
https://www.merriam-webster.com/dictionary/lymphadenectomy
IPA: /ˌlɪmfəˌdɛˈnɛktəmi/
Phonetic Spelling: lim-fuh-deh-nek-tuh-mee

- **parachute** (as in parachute technique)

Pronunciation link:
https://www.merriam-webster.com/dictionary/parachute
IPA: /ˈpærəˌʃut/
Phonetic Spelling: par-uh-shoot

- **cavernous**

Pronunciation link:
https://www.merriam-webster.com/dictionary/cavernous

IPA: /ˈkævərnəs/
Phonetic Spelling: kav-er-nus

- **transformation**

Pronunciation link:
https://www.merriam-webster.com/dictionary/transformation
IPA: /ˌtrænsfərˈmeɪʃən/
Phonetic Spelling: trans-fer-may-shun

- **hepatoduodenal**

Pronunciation link:
https://www.howtopronounce.com/hepatoduodenal
IPA: /ˌhɛpətoʊduːˈliːnəl/
Phonetic Spelling: hep-uh-toh-doo-dee-nul

- **hepaticojejunostomy**

Pronunciation link:
https://www.howtopronounce.com/hepaticojejunostomy
IPA: /ˌhɛpətɪkoʊdʒəˈdʒuːnɒstɒmi/ (American: /ˌhɛpətɪkoʊdʒəˈdʒunɑsti/)
Phonetic Spelling: hep-at-ik-oh-je-joo-nos-toh-mee

- **pancreaticojejunostomy**

Pronunciation link:
https://www.howtopronounce.com/pancreaticojejunostomy
IPA: /ˌpæŋkriætɪkoʊdʒəˈdʒuːnɒstɒmi/ (American: /ˌpæŋkriætɪkoʊdʒəˈdʒunɑsti/)
Phonetic Spelling: pan-kree-at-ik-oh-je-joo-nos-toh-mee