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Title: Femoral Vascular Graft Implantation in a Swine Model to Test Small-Diameter Vascular Grafts

Authors and Affiliations:

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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: 22
Number of Shots: 35

Introduction

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

1.1. **Georgina Iraola-Picornell:** We present a standardized surgical protocol to evaluate tissue-engineered vascular grafts in a porcine model of an end-to-end femoral artery transplantation, bridging preclinical testing and clinical application, especially for vascular grafts less than 6 mm of diameter **[1]**.

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 technologies are currently used to advance research in your field?

1.2. **Christian Muñoz-Guijosa:** In our field, several advanced technologies play a key role in driving research forward. Reproducibly implanting small-caliber vascular grafts in the femoral position of pigs requires refined microsurgical techniques, precise perioperative management protocols and also, high-resolution ultrasound and angiography **[1]**.

1.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 3.3.1*

What research gap are you addressing with your protocol?

1.3. **Georgina Iraola-Picornell:** Our protocol aims to standardize large-animal models for testing small-diameter grafts in arterial positions like the femoral artery to evaluate new tissue-engineering vascular grafts **[1]**.

1.3.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 3.8.1*

What research questions will your laboratory focus on in the future?

1.4. **Christian Muñoz-Guijosa:** We aim to evaluate short-term patency and host response to a bioengineered vascular graft, named VasCraft, in a preclinical model. This graft comprises in a decellularized human saphenous vein and reendothelialized with umbilical cord blood-derived endothelial cells **[1]**.

1.4.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera. *Suggested B-roll: 4.2.1*

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

Ethics Title Card

This research has been approved by the Animal Experimentation Unit Ethical Committee at the Germans Trias i Pujol Health Research Institute (IGTP) and Government Authorities of the Generalitat de Catalunya

Protocol

Videographer's NOTE: Some shots without a clapboard were B-roll and are not necessary.

2. Hemodynamic Monitoring and Preparation of the Surgical Area

Demonstrator: Georgina Iraola-Picornell

2.1. To begin, place the anesthetized animal in a ventral recumbent position on the operating table **[1-TXT]**. Using tape or bandages, secure each limb to the table to prevent movement during the procedure **[2-TXT]**.

2.1.1. WIDE: Talent placing the animal on the operating table in a ventral recumbent position. **TXT: Anesthesia (Induction): Dexmedetomidine (0.03 mg/kg); midazolam (0.3 mg/kg); Ketamine (3 mg/kg)**

2.1.2. Talent taping or bandaging the limbs securely to the table. **TXT: Maintain anesthesia with sevoflurane (1 - 3%)**

2.2. Place surface electrodes on the animal's limbs to monitor electrocardiogram changes and heart rate throughout the surgical procedure **[1]**.

2.2.1. Talent attaching electrodes to each limb of the animal.

2.3. Next, position a pulse oximeter on the tongue or the corner of the lip to monitor oxygen saturation continuously **[1]**.

2.3.1. Talent positioning the pulse oximeter sensor gently on the animal's tongue or lip.

2.4. Wrap a non-invasive blood pressure cuff around the animal's forelimb **[1]** and insert a temperature probe into the esophagus to measure body temperature **[2].**

2.4.1. Talent fitting a blood pressure cuff snugly around the forelimb of the animal.

2.4.2. Talent inserting the probe carefully into the esophagus of the animal.

2.5. Now, using surgical clippers, shave both the right and left femoral areas **[1]**. Wash the shaved areas with surgical soap to remove any debris **[2]** and disinfect the cleaned areas with three alternating rounds of 0.7 percent iodine and 70 percent ethanol under sterile conditions **[3]**.

2.5.1. Talent shaving the right and left femoral regions using surgical clippers.

2.5.2. Talent scrubbing the shaved areas with surgical soap.

2.5.3. Talent disinfecting the areas by wiping the area with an iodine-soaked cotton.

2.6. Perform a surgical handwash thoroughly **[1]**, then wear a sterile gown and gloves **[2]**.

2.6.1. Talent scrubbing hands and forearms following surgical protocol.

2.6.2. Talent donning a sterile gown and gloves.

2.7. Drape the animal with a sterile surgical sheet to maintain aseptic conditions **[1]** and monitor the depth of anesthesia every 10 minutes throughout the surgery **[2]**.

2.7.1. Talent covering the animal completely with a sterile drape.

2.7.2. Talent performing toe pinch to check anesthesia.

3. Vascular Graft Implantation

Demonstrator: Christian Muñoz-García

~~3.1. For intraoperative analgesia, administer a fentanyl bolus if the animal shows signs of pain such as an increase in heart rate **[1]**.~~ Author's NOTE: Step removed

~~3.1.1. Talent injecting fentanyl into the animal's catheter upon observing elevated heart rate.~~

3.2. Use an ultrasound probe to locate the right femoral artery and assess the blood flow **[1-TXT]**.

3.2.1. Shot of the Ultrasound screen showing the right femoral artery and its blood flow. **TXT: For intraoperative analgesia, administer a fentanyl bolus** NOTE: The deleted information from step 3.1 is placed as a text overlay here

3.3. Using an electric scalpel, make a 7 to 10-centimeter vertical incision perpendicular to the linea inguinalis **[1]**.

3.3.1. Talent making a vertical incision with an electric scalpel over the marked surgical site. Videographer's NOTE: 3.3.1, 3.4.1, and 3.4.2 are combined.

3.4. Spear the subcutaneous tissues to access the underlying muscle layers **[1]** and electrocoagulate the small surrounding blood vessels to achieve hemostasis **[2]**.

3.4.1. Talent spreading apart the subcutaneous tissues.

3.4.2. Talent applying electrocoagulation tool to small vessels until bleeding stops.

3.5. Use two Weitlaner retractors to gently separate the Sartorius, Rectus Femoris, Gracilis, and Pectineus muscles for better exposure to the superficial femoral artery **[1]**.

3.5.1. Talent inserting and adjusting two Weitlaner retractors to separate the Sartorius, Rectus Femoris, Gracilis, and Pectineus muscles.

~~3.6. Administer 300 international units per kilogram of heparin intravenously to prevent intraoperative thrombosis prior to femoral artery clamping **[1]**.~~ Author's NOTE: Step removed

~~3.6.1. Talent injecting heparin intravenously using a syringe.~~

3.7. Now, apply vascular clamps proximally and distally on the right superficial femoral artery to achieve complete occlusion **[1-TXT]**, ensuring the distance between clamps is approximately 1 centimeter longer than the segment to be resected **[2]**.

3.7.1. Talent placing vascular clamp above the intended resection site. **TXT: Administer 300 IU/kg heparin IV to prevent thrombosis before femoral artery clamping** NOTE: The deleted information from step 3.6 is placed as a text overlay here
Videographer's NOTE: 3.7.1 and 3.7.2 are combined

3.7.2. Shot showing both the clamps in place.

3.8. Confirm that the replacement graft is anatomically compatible in both length and diameter with the arterial segment to be resected **[1-TXT]**.

3.8.1. Talent holding the graft alongside the clamped arterial segment. **TXT: Ensure clamps are correctly positioned to control blood flow near the resection site** NOTE: The deleted information from step 3.9 is placed as a text overlay here

~~3.9. Ensure the clamps are properly positioned to control blood flow around the area of resection **[1]**.~~ Author's NOTE: Step removed

~~3.9.1. Talent pointing to the clamped area.~~

3.10. Next, excise a 5-centimeter segment of the right superficial femoral artery in a slightly oblique manner to facilitate posterior termino-terminal anastomosis near the clamps **[1]**.

3.10.1. Shot of cutting the artery at an oblique angle using surgical scissors or a scalpel.

~~3.11. Then, cut the proximal and distal ends of the graft to match the resected segment **[1]**.~~
Author's NOTE: Step removed

~~3.11.1. Talent trimming the end of the graft using micro scissors.~~

3.12. Using a continuous 7-0 *(7-oh)* Prolene suture in a running stitch pattern, suture the proximal and distal anastomoses of the experimental graft to the clamped artery **[1]** from posterior to anterior and medial to lateral **[2]**.

3.12.1. Talent performing termino-terminal anastomosis with running suture.

3.12.2. Shot of fully stitched segment.

3.13. Now, unclamp the proximal and distal clamps to restore vascular flow **[1]** and verify the absence of blood leakage from the anastomoses **[2]**.

3.13.1. Talent carefully releasing clamps.

3.13.2. Talent pointing to the are showing no blood leakage.

3.14. Then, close the muscle and subcutaneous tissue using a resorbable size 1 continuous suture **[1]**, and close the skin with a resorbable size 0 intradermal continuous suture **[2]**.

3.14.1. Talent suturing muscle and subcutaneous tissue using a resorbable size 1 continuous suture.

3.14.2. Talent closing the skin with a resorbable size 0 intradermal continuous suture.

3.15. Finally, repeat the same surgical procedure on the left superficial femoral artery using the autograft as a control of the graft technique, if needed, and apply a sterile transparent dressing over the surgical site **[1].** NOTE: VO is modified to get covered with the filmed shot 3.15.1.

3.15.1. Talent placing and pressing down a transparent dressing to cover the incision.

~~3.15.2. Talent positioning tools and graft materials.~~

Results

4. Results

4.1. The successful incorporation of the autograft into the femoral artery and its patency were verified non-invasively using Doppler ultrasound. On day 7, the ultrasound confirmed 100% graft patency with no signs of acute rejection or infection **[1]**.

1.1.1. LAB MEDIA: Figure 2A. *Video editor: Highlight the area labeled as "proximal suture"*.

4.2. On day 30, Doppler ultrasound confirmed persistent graft patency and consistent diameter, with no visible defects **[1]**.

4.2.1. LAB MEDIA: Figure 2C.

4.3. Angiography on day 30 further validated patency with no structural abnormalities in the arterial graft **[1]**.

4.3.1. LAB MEDIA: Figure 2D.

4.4. Histological staining of the extracted graft at day 30 showed intact vascular wall structure, including clearly defined tunica adventitia **[1]**, media **[2]**, and intima layers **[3]**.

4.4.1. LAB MEDIA: Figure 3C. *Video editor: Highlight the part labeled "tunica adventitia*".

4.4.2. LAB MEDIA: Figure 3C. *Video editor: Highlight the part "tunica media".*

4.4.3. LAB MEDIA: Figure 3C. *Video editor: Highlight the part "tunica intima".*

4.5. Immunohistofluorescence staining revealed proper localization of endothelial and smooth muscle markers across all vascular layers of the autograft, supporting functional tissue integration **[1]**.

4.5.1. LAB MEDIA: Figure 3D

Pronunciation Guide:

dexmedetomidine
Pronunciation link: https://www.howtopronounce.com/dexmedetomidine YouTubeCollins Dictionary+10How To Pronounce+10Definitions+10
IPA (AmE): /dɛksˌmɛdəˈtoʊmɪˌdin/
Phonetic: deks-med-eh-TOH-mi-deen

midazolam
No confirmed link found (not available in Merriam-Webster)
IPA (AmE): /ˌmɪdəˈzoʊləm/
Phonetic: mid-uh-ZOH-luhm

sevoflurane
No confirmed link found
IPA (AmE): /ˌsɛvoʊˈflʊərin/
Phonetic: sevo-FLOOR-een

linea inguinalis
linea link: https://www.merriam-webster.com/medical/linea How To PronounceMerriam-Webster+6Merriam-Webster+6Merriam-Webster+6
IPA: /ˈlɪniə/
Phonetic: LEE-nee-uh
inguinal link: https://www.merriam-webster.com/dictionary/inguinal Merriam-Webster+3Merriam-Webster+3Definitions+3
IPA: /ˈɪŋgwənəl/
Phonetic: ING-gwuh-nuhl

anastomosis
Link: https://www.merriam-webster.com/dictionary/anastomosis Merriam-Webster+13Merriam-Webster+13Oxford English Dictionary+13
IPA: /əˌnæs.təˈmoʊ.sɪs/
Phonetic: uh-NAS-tuh-MOH-sis

esophagus
No confirmed link found (not looked up, but standard)
IPA: /ɪˈsɒf.əgəs/
Phonetic: ih-SOF-uh-guhs

Weitlaner
No confirmed link found (proper noun, surgical retractor)
IPA (estim.): /ˈvaɪtlənər/
Phonetic: VYTL-uh-nuhr

electrocoagulate
No confirmed link found
IPA: /ɪˌlɛk.troʊˈkoʊ.əgjʊ.leɪt/
Phonetic: ih-LEK-troh-KOH-uh-gyu-layt

anastomoses (plural)
Same as anastomosis but plural
IPA: /əˌnæs.təˈmoʊˌsiːz/
Phonetic: uh-NAS-tuh-MOH-seez

fentanyl
No confirmed link found
IPA: /ˈfɛntənəl/
Phonetic: FEN-tuh-nul

Sartorius, **Gracilis**, **Pectineus**, **Rectus Femoris** (muscles)
No confirmed links found; classical Latin-derived terms
Sartorius: /sɑrˈtɔːriəs/ → sar-TAWR-ee-us
Gracilis: /ˈgreɪsɪlɪs/ → GRAY-sih-lis
Pectineus: /pɛkˈtɪniəs/ → pek-TIN-ee-us
Rectus: /ˈrɛktəs/ → REK-tus
Femoris: /fɪˈmɔːrɪs/ → fih-MOR-is

adventitia, **intima**
No confirmed links found
adventitia: /əˌdvɛnˈtɪʃə/ → uh-dven-TISH-uh
intima: /ˈɪntɪmə/ → IN-tih-muh