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## **Title: A Surgical Method for Subvalvular Structure Intervention Through a Transaortic Approach in Normal Bama Pigs**

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## Author Questionnaire

**1.** We have marked your project as author-provided footage, meaning you film the video yourself and provide JoVE with the footage to edit. JoVE will not send the videographer. Please confirm that this is correct.

✓ Correct

**2. Interview statements:** Which interview statement filming option is the most appropriate for your group? **Please select one.**



Interview Statements are read by JoVE's voiceover talent.

### Current Protocol Length

Number of Steps: 21

Number of Shots: 39

# Introduction

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**NOTE to VO producer:** Please generate the VO for section 1 interviews

**Authors:** Please note that **the questions will not appear on screen.** *Please answer in **stand-alone full sentence with sufficient context.***

**Answers are slightly edited in accordance with journal guidelines.**

## INTRODUCTION:

**REQUIRED:** Summarize your research focus and the main questions it aims to answer.

- 1.1. This study develops a reproducible transaortic surgical method to study subvalvular interventions under clinically relevant conditions.

1.1.1. B. roll: 2.2.1

~~Describe the research contexts or systems in which this protocol can be applied.~~

- 1.2. This protocol can be applied to surgical training, histological analysis, and evaluation of subvalvular intervention strategies.

1.2.1. B. roll: .2.3. 1

## CONCLUSION:

~~Describe the most important consideration or challenge when performing this protocol.~~

- 1.3. The key challenge is achieving adequate exposure and precise resection while avoiding damage along the surgical access pathway.

1.3.1. B. roll: .3.5.1

~~Are there any additional methods or analyses that can be performed following this procedure?~~

- 1.4. Following intervention, animals can undergo echocardiography, CMR, and other hemodynamic assessments to evaluate cardiac function.

1.4.1. B. roll: 2.7.1

~~How can future studies build on this work? Describe the questions or research directions that can be investigated next.~~

- 1.5. Future studies can explore long-term functional outcomes, optimize resection strategies, and investigate mechanisms underlying subvalvular intervention effects.

*1.5.1. B. roll: 3.2.1*

**Ethics Title Card**

This research has been approved by the Institutional Animal Care and Use Committee (IACUC) at the Fuwai Hospital Chinese Academy of Medical Sciences

# Protocol

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## 2. Thoracic Cavity Exposure and Cardiac Mobilization

**Demonstrator:** Wei Wang

- 2.1. After preparing the animal, make a midline incision along the sternum, extending from the suprasternal notch to approximately 2 centimeters below the xiphoid process [1-TXT]. Using an electrocautery device, incise the skin and subcutaneous tissues while maintaining an incision length of approximately 20 centimeters [2].
  - 2.1.1. LAB MEDIA: 69116-1.mp4 00:00:00 – 00:00:06 **TXT: Anesthesia: Induction: 1% propofol via the auricular vein (2 – 4 mg/kg); Maintenance: Continuous intravenous infusion of propofol (6 - 10 mg/kg/h)**
  - 2.1.2. LAB MEDIA: 69116-1.mp4 00:00:07 – 00:00:11
- 2.2. Continue to separate the pectoralis major muscles and the periosteum of the sternum. Fully expose the anterior surface of the sternum [1].
  - 2.2.1. LAB MEDIA: 69116-1.mp4 00:00:12 – 00:00:20
- 2.3. Gently retract the lateral tissues with the help of an assistant to maintain a clear surgical field [1].
  - 2.3.1. LAB MEDIA: 69116-1.mp4 00:00:46 – 00:00:55
- 2.4. After exposing the sternum, insert a Lebsche knife beneath the xiphoid process and apply upward traction [1].
  - 2.4.1. LAB MEDIA: 69116-1.mp4 00:01:00 – 00:01:05
- 2.5. Using a small hammer, carefully and evenly tap the proximal end of the Lebsche knife [1]. Gradually split the sternum along the midline, proceeding cranially until the thoracic cavity is opened [2].
  - 2.5.1. LAB MEDIA: 69116-1.mp4 00:01:05 – 00:01:25
  - 2.5.2. LAB MEDIA: 69116-1.mp4 00:02:50 – 00:03:00

- 2.6. Maintain continuous upward traction throughout the process to avoid deviation or injury to the pericardium [1]. After completing the sternal division, place a Finochietto rib retractor [2]. Slowly expand the thoracic cavity bilaterally to widen the operative field while avoiding excessive retraction to prevent pleural injury or rib fractures [3].

2.6.1. LAB MEDIA: 69116-1.mp4 00:03:00 – 00:03:05

2.6.2. LAB MEDIA: 69116-1.mp4 00:04:42 – 00:04:52

2.6.3. LAB MEDIA: 69116-1.mp4 00:05:06 – 00:05:29

- 2.7. Perform blunt dissection bilaterally to separate the pericardium from the mediastinal pleura and adjacent connective tissues [1].

2.7.1. LAB MEDIA: 69116-1.mp4 00:05:35 – 00:05:40 and 06:00:00-00:06:09

- 2.8. After completing the dissection, expose the heart under direct visualization [1]. Confirm clear identification of key anatomical structures including the aorta, pulmonary artery, right atrial appendage, cardiac apex, and coronary sinus [2].

2.8.1. LAB MEDIA: 69116-1.mp4 00:06:20 – 00:06:30

2.8.2. LAB MEDIA: 69116-1.mp4 00:07:14 – 00:07:18

### **3. Establishment of Cardiopulmonary Bypass (CPB)**

- 3.1. Once adequate cardiac exposure is achieved, place a purse-string suture at the base of the right atrial appendage [1]. Make a small incision within the suture loop [2] and insert a venous drainage cannula obliquely downward along the axis of the right atrial appendage to establish the venous return pathway for cardiopulmonary bypass [3].

3.1.1. LAB MEDIA: 69116-1.mp4 00:20:33-00:20:39 and 00:21:21-00:21:26

3.1.2. LAB MEDIA: 69116-1.mp4 00:30:16 – 00:30:25

3.1.3. LAB MEDIA: 69116-1.mp4 00:30:51 – 00:30:58

- 3.2. Advance the cannula approximately 3 to 4 centimeters to ensure that its tip enters the

right atrial cavity and secure the cannula to the atrial appendage using silk sutures to prevent slippage or leakage [1].

3.2.1. LAB MEDIA: 69116-1.mp4 00:31 :00 – 00:31:28

3.3. Insert a perfusion cannula through the right atrial appendage region into the coronary sinus to serve as the inflow pathway for cardioplegia delivery and myocardial perfusion [1].

3.3.1. LAB MEDIA: 69116-6.mp4 00:00:16–00:00:21 and 69116-6.mp4 00:00:45–00:00:54

3.4. Activate the venous return pump to initiate partial venous drainage. Gradually open the arterial pump to maintain perfusion pressure at 60 to 80 millimeters of mercury [1].

3.4.1. LAB MEDIA: 69116-1.mp4 00:40:03 – 00:40:10

3.5. Infuse cooled high-potassium cardioplegia via the coronary sinus to induce cardiac arrest and record the arrest time [1].

3.5.1. LAB MEDIA: : 69116-1.mp4 00:40:45-00:40:50 **Author's NOTE:** We confirm that clear footage for this step is not available in the current recording. However, this is an essential procedural step to achieve cardiac arrest and ensure a stable operative field. We suggest retaining this

3.6. Apply pre-prepared crushed ice saline slush over the cardiac surface to further reduce myocardial temperature, decrease metabolic demand, and enhance myocardial protection [1].

3.6.1. LAB MEDIA: 69116-1.mp4 00:40:50 – 00:40:53 and 00:41:05-00:41:10

#### **4. Left Ventricular Exposure and Subvalvular Structure Intervention via Aortic Access**

4.1. After achieving cardioplegic arrest and hypothermic protection, make a transverse incision approximately 1 to 1.5 centimeters in length on the anterior wall of the ascending aorta [1]. Position the incision approximately 1.5 to 2 centimeters above the aortic valve annulus and orient it perpendicular to the long axis of the aorta [2].

4.1.1. LAB MEDIA: 69116-1.mp4 00:44:48 – 00:44:55 and 00:45:20-00:45:30

4.1.2. LAB MEDIA: 69116-1.mp4 00:45:50 – 00:46:06

- 4.2. Insert two curved sheet hooks into the aortic incision from the left dorsal and ventral sides [1] and gently retract the incision laterally to open the aortic root and expand the surgical field [2].

4.2.1. LAB MEDIA: 69116-1.mp4 00:46:30 – 00:46:45

4.2.2. LAB MEDIA: 69116-7.mp4 00:00:00 – 00:00:25

- 4.3. Now, advance small curved scissors through the aortic incision along the axis of the aorta toward the left ventricular chamber. Use the traction suture to expose the target subvalvular region [1].

4.3.1. LAB MEDIA: 69116-1.mp4 00:54:13 – 00:54:25

- 4.4. Under direct visualization, orient the scissors horizontally [1] and cut the designated subvalvular structures in a controlled manner [2]. Remove the resected tissue and hand it to the assistant [3].

4.4.1. LAB MEDIA: 69116-1.mp4 00:54:33 – 00:54:43

4.4.2. LAB MEDIA: 69116-1.mp4 00:58:20 – 00:58:33

4.4.3. LAB MEDIA: 69116-10.mp4 00:00:40 – 00:00:51

- 4.5. Finally, close the aortic incision using continuous absorbable sutures [1]. Begin at one end of the incision and sequentially pass the needle through the intima and media using evenly spaced stitches to ensure complete watertight closure [2]. Following aortic incision closure, restore cardiac perfusion and observe spontaneous cardiac rebeating [3].

4.5.1. LAB MEDIA: 69116-1.mp4 01:05:47 – 01:06:00

4.5.2. LAB MEDIA: 69116-1.mp4 01:20:13-01:20:16 and – 01:21:07- 01:21:15

4.5.3. LAB MEDIA: 69116-1.mp4 01:25:10 – 01:25:20

# Results

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## 5. Results

5.1. The total operation time was approximately 2.5 to 3 hours [1].

5.1.1. LAB MEDIA: Table 1. *Video editor: Highlight the row "Total operative time (h)" and the value "2.5-3"*

5.2. Cardiopulmonary bypass was maintained for about 60 to 71 minutes [1].

5.2.1. LAB MEDIA: Table 1. *Video editor: Highlight the row "Cardiopulmonary bypass (CPB) duration (min)" and the value "60-71"*

5.3. After restoration of cardiac perfusion, spontaneous cardiac rebeating was observed in all animals with a stable sinus rhythm [1].

5.3.1. LAB MEDIA: Table 1. *Video editor: Highlight the row "Rate of spontaneous cardiac resumption (%)" showing 100%*

5.4. No apparent complications or adverse events were observed after the procedure [1].

5.4.1. LAB MEDIA: Table 1. *Video editor: Highlight the row "Incidence of adverse events (%)"*

1. Sternum

Pronunciation link: <https://www.merriam-webster.com/dictionary/sternum>

IPA: /'stər-nəm/

Phonetic Spelling: STUR • nuhm

2. Suprasternal

Pronunciation link: <https://www.merriam-webster.com/dictionary/suprasternal>

IPA: /,sü-prə-'stər-nəl/

Phonetic Spelling: soo • pruh • STUR • nuhl

3. Xiphoid

Pronunciation link: <https://www.merriam-webster.com/dictionary/xiphoid>

IPA: /'zī-fōid/

Phonetic Spelling: ZY • foyd

4. Electrocautery  
Pronunciation link: <https://www.merriam-webster.com/dictionary/electrocautery>  
IPA: /i-,lek-trō-'kô-tə-rē/  
Phonetic Spelling: ee • lek • troh • KAW • tuh • ree
5. Subcutaneous  
Pronunciation link: <https://www.merriam-webster.com/dictionary/subcutaneous>  
IPA: /,səb-kyū-'tā-nē-əs/  
Phonetic Spelling: sub • kyoo • TAY • nee • uhs
6. Anesthesia  
Pronunciation link: <https://www.merriam-webster.com/dictionary/anesthesia>  
IPA: /,a-nəs-'thē-zhə/  
Phonetic Spelling: an • uhs • THEE • zhuh
7. Propofol  
Pronunciation link: <https://www.merriam-webster.com/dictionary/propofol>  
IPA: /'prō-pə-,fōl/  
Phonetic Spelling: PROH • puh • fawl
8. Auricular  
Pronunciation link: <https://www.merriam-webster.com/dictionary/auricular>  
IPA: /ō-'ri-kyə-lər/  
Phonetic Spelling: aw • RIK • yuh • ler
9. Intravenous  
Pronunciation link: <https://www.merriam-webster.com/dictionary/intravenous>  
IPA: /,in-trə-'vē-nəs/  
Phonetic Spelling: in • truh • VEE • nuhs
10. Pectoralis  
Pronunciation link: <https://www.merriam-webster.com/dictionary/pectoralis>  
IPA: /,pek-tə-'rā-ləs/  
Phonetic Spelling: pek • tuh • RAY • luhs
11. Periosteum  
Pronunciation link: <https://www.merriam-webster.com/dictionary/periosteum>  
IPA: /,per-ē-'ā-stē-əm/  
Phonetic Spelling: pair • ee • AA • stee • uhm
12. Anterior  
Pronunciation link: <https://www.merriam-webster.com/dictionary/anterior>

IPA: /an-'tir-ē-ər/

Phonetic Spelling: an • TEER • ee • er

13. Proximal

Pronunciation link: <https://www.merriam-webster.com/dictionary/proximal>

IPA: /'präk-sə-məl/

Phonetic Spelling: PRAAK • suh • muhl

14. Cranially

Pronunciation link: <https://www.merriam-webster.com/dictionary/cranial>

IPA: /'krā-nē-əl-ē/

Phonetic Spelling: KRAY • nee • uh • lee

15. Thoracic

Pronunciation link: <https://www.merriam-webster.com/dictionary/thoracic>

IPA: /thŏ-'ra-sik/

Phonetic Spelling: thaw • RAS • ik

16. Pericardium

Pronunciation link: <https://www.merriam-webster.com/dictionary/pericardium>

IPA: /,per-ə-'kär-dē-əm/

Phonetic Spelling: pair • uh • KAR • dee • uhm

17. Finochietto

Pronunciation link: No confirmed link found

IPA: /,fi:-noʊ-ki'ε-toʊ/

Phonetic Spelling: fee • noh • kee • EH • toh

18. Pleural

Pronunciation link: <https://www.merriam-webster.com/dictionary/pleural>

IPA: /'plūr-əl/

Phonetic Spelling: PLOOR • uhl

19. Dissection

Pronunciation link: <https://www.merriam-webster.com/dictionary/dissection>

IPA: /dī-'sek-shən/

Phonetic Spelling: dy • SEK • shuhn

20. Mediastinal

Pronunciation link: <https://www.merriam-webster.com/dictionary/mediastinal>

IPA: /,mē-dē-ə-'stī-nəl/

Phonetic Spelling: mee • dee • uh • STY • nuhl

21. Visualization

Pronunciation link: <https://www.merriam-webster.com/dictionary/visualization>

IPA: /ˌvi-zhə-wə-lə-'zā-shən/

Phonetic Spelling: vi • zhuh • wuh • luh • ZAY • shuhn

22. Anatomical

Pronunciation link: <https://www.merriam-webster.com/dictionary/anatomical>

IPA: /ˌa-nə-'tä-mi-kəl/

Phonetic Spelling: an • uh • TAA • mi • kuh1

23. Aorta

Pronunciation link: <https://www.merriam-webster.com/dictionary/aorta>

IPA: /ā-'ōr-tə/

Phonetic Spelling: ay • OR • tuh

24. Pulmonary

Pronunciation link: <https://www.merriam-webster.com/dictionary/pulmonary>

IPA: /'pʊl-mə-,ner-ē/

Phonetic Spelling: PUUL • muh • nair • ee

25. Atrial

Pronunciation link: <https://www.merriam-webster.com/dictionary/atrial>

IPA: /'ā-trē-əl/

Phonetic Spelling: AY • tree • uhl

26. Coronary

Pronunciation link: <https://www.merriam-webster.com/dictionary/coronary>

IPA: /'kōr-ə-,ner-ē/

Phonetic Spelling: KOR • uh • nair • ee

27. Cardiopulmonary

Pronunciation link: <https://www.merriam-webster.com/dictionary/cardiopulmonary>

IPA: /ˌkär-dē-ō-'pʊl-mə-,ner-ē/

Phonetic Spelling: kar • dee • oh • PUUL • muh • nair • ee

28. Cannula

Pronunciation link: <https://www.merriam-webster.com/dictionary/cannula>

IPA: /'kan-yə-lə/

Phonetic Spelling: KAN • yuh • luh

29. Obliquely

Pronunciation link: <https://www.merriam-webster.com/dictionary/obliquely>

IPA: /ō-'blēk-lē/

Phonetic Spelling: oh • BLEEK • lee

30. Perfusion

Pronunciation link: <https://www.merriam-webster.com/dictionary/perfusion>

IPA: /pər-'fyü-zhən/

Phonetic Spelling: per • FY00 • zhuhn

31. Cardioplegia

Pronunciation link: <https://www.merriam-webster.com/dictionary/cardioplegia>

IPA: /ˌkär-dē-ō-ˈplē-jē-ə/

Phonetic Spelling: kar • dee • oh • PLEE • jee • uh

32. Myocardial

Pronunciation link: <https://www.merriam-webster.com/dictionary/myocardial>

IPA: /ˌmī-ō-ˈkär-dē-əl/

Phonetic Spelling: my • oh • KAR • dee • uhl

33. ECG

Pronunciation link: <https://www.merriam-webster.com/dictionary/ECG>

IPA: /ˌē-,sē-ˈjē/

Phonetic Spelling: ee • see • JEE

34. Hypothermic

Pronunciation link: <https://www.merriam-webster.com/dictionary/hypothermic>

IPA: /ˌhī-pō-ˈthər-mik/

Phonetic Spelling: hy • poh • THUR • mik

35. Ventricular

Pronunciation link: <https://www.merriam-webster.com/dictionary/ventricular>

IPA: /ven-ˈtri-kyə-lər/

Phonetic Spelling: ven • TRIK • yuh • ler

36. Aortic

Pronunciation link: <https://www.merriam-webster.com/dictionary/aortic>

IPA: /ā-ˈōr-tik/

Phonetic Spelling: ay • OR • tik

37. Annulus

Pronunciation link: <https://www.merriam-webster.com/dictionary/annulus>

IPA: /ˈan-yə-ləs/

Phonetic Spelling: AN • yuh • luhs

38. Perpendicular

Pronunciation link: <https://www.merriam-webster.com/dictionary/perpendicular>

IPA: /ˌpər-pən-ˈdi-kyə-lər/

Phonetic Spelling: per • puhn • DIK • yuh • ler

39. Dorsal

Pronunciation link: <https://www.merriam-webster.com/dictionary/dorsal>

IPA: /'dɔr-səl/

Phonetic Spelling: DOR • suhl

40. Ventral

Pronunciation link: <https://www.merriam-webster.com/dictionary/ventral>

IPA: /'ven-trəl/

Phonetic Spelling: VEN • truhl

41. Subvalvular

Pronunciation link: No confirmed link found

IPA: /,səb-'val-vyə-lər/

Phonetic Spelling: sub • VAL • vyuh • ler

42. Resected

Pronunciation link: <https://www.merriam-webster.com/dictionary/resect>

IPA: /ri-'sekt-əd/

Phonetic Spelling: ri • SEK • tid

43. Absorbable

Pronunciation link: <https://www.merriam-webster.com/dictionary/absorbable>

IPA: /əb-'zɔr-bə-bəl/

Phonetic Spelling: ub • ZOR • buh • buhl

44. Sequentially

Pronunciation link: <https://www.merriam-webster.com/dictionary/sequentially>

IPA: /si-'kwen-shə-lē/

Phonetic Spelling: si • KWEN • shuh • lee

45. Intima

Pronunciation link: <https://www.merriam-webster.com/dictionary/intima>

IPA: /'in-tə-mə/

Phonetic Spelling: IN • tuh • muh

46. Saline

Pronunciation link: <https://www.merriam-webster.com/dictionary/saline>

IPA: /'sā-lēn/

Phonetic Spelling: SAY • leen

47. Sinus

Pronunciation link: <https://www.merriam-webster.com/dictionary/sinus>

IPA: /'sī-nəs/

Phonetic Spelling: SY • nuhs

48. Operative

Pronunciation link: <https://www.merriam-webster.com/dictionary/operative>

IPA: /'ä-pə-rə-tiv/

Phonetic Spelling: AA • puh • ruh • tiv

