

Submission ID #: 69116

Scriptwriter Name: Poornima G

Project Page Link: <https://review.jove.com/account/file-uploader?src=21080428>

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

Authors and Affiliations:

Chengtai Ma^{1,2,3*}, Wei Wang^{4*}, Hao Jia^{2,3,4*}, Xiao Chen³, Ningning Zhang³, Peiyuan Li^{2,3}, Xiulin Zhang^{2,3}, Jiangping Song^{2,3,4,5,6}

¹Department of Critical Care Medicine, Renmin Hospital of Wuhan University

²Beijing Key Laboratory for Xenotransplantation, Fuwai Hospital, National Center for Cardiovascular Diseases, Chinese Academy of Medical Sciences and Peking Union Medical College

³State Key Laboratory of Cardiovascular Disease, Fuwai Hospital, National Center for Cardiovascular Diseases, Chinese Academy of Medical Sciences and Peking Union Medical College

⁴Department of Cardiac Surgery, Fuwai Hospital, National Center for Cardiovascular Diseases, Chinese Academy of Medical Sciences and Peking Union Medical College

⁵Shenzhen Key Laboratory of Cardiovascular Disease, Fuwai Hospital, Chinese Academy of Medical Sciences

⁶Department of Cardiac Surgery, Fuwai Yunnan Hospital, Chinese Academy of Medical Sciences, Affiliated Cardiovascular Hospital of Kunming Medical University

*These authors contributed equally

Corresponding Authors:

Jiangping Song

fwsongjiangping@126.com

Email Addresses for All Authors:

Chengtai Ma

Wei Wang

Hao Jia

Xiao Chen

Ningning Zhang

Peiyuan Li

Xiulin Zhang

Jiangping Song

machtad@126.com

fuwai_wangwei@163.com

uwai_jiahao@163.com

584664708@qq.com

nzhang1215@163.com

lipyvip@163.com

xiulinzh@163.com

fwsongjiangping@126.com

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

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

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

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: /'pul-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-'pul-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

