Video Article

# Microsurgical Venous Pouch Arterial-Bifurcation Aneurysms in the Rabbit Model: Technical Aspects

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## Abstract

For ruptured human cerebral aneurysms endovascular embolization has become an equivalent alternative to aneurysm clipping.[1] However, large clinical trials have shown disappointing long-term results with unacceptable high rates of aneurysm recanalization and delayed aneurysm rupture.[2] To overcome these problems, animal experimental studies are crucial for the development of better endovascular devices.[3-5]

Several animal models in rats, rabbits, canines and swine are available.[6-8] Comparisons of the different animal models showed the superiority of the rabbit model with regard to hemodynamics and comparability of the coagulation system and cost-effectiveness.[9-11]

The venous pouch arterial bifurcation model in rabbits is formed by a venous pouch sutured into an artificially created true bifurcation of both common carotid arteries (CCA). The main advantage of this model are true bifurcational hemodynamics.[12] The major drawbacks are the sofar high microsurgical technical demands and high morbidity and mortality rates of up to 50%.[13] These limitations have resulted in less frequent use of this aneurysm model in the recent years. These shortcomings could be overcome with improved surgical procedures and modified peri- and postoperative analgetic management and anticoagulation.[14-16] Our techniques reported in this paper demonstrate this optimized technique for microsurgical creation of arterial bifurcation aneurysms.

## Video Link

The video component of this article can be found at https://www.jove.com/video/2718/

## Protocol

### 1. Positioning and preparation of the animal

The experiments were approved by the responsible local ethical committee and performed according to the Felasa guidelines.

1. Start general anesthesia of the female New Zealand White rabbit (2.5-3.5 kg) with intramuscular injection of Ketamin (30mg/kg) and Xylazine (6mg/kg) and continue after mechanical intubation (tube diameter 4mm, length 18mm) with gas anesthesia (Isoflurane) under ECG monitoring. Perform pain monitoring via toe pinch all 15 minutes and adapt anesthesia in case of positive response.
2. Fix the rabbit in supine position on a bodywarm plate.
3. Prepare the area for surgery by removal of hair reaching from the angle of jaw down to the middle of the thorax. Perform all procedures under sterile conditions.

### 2. Preparation of the external jugular vein

1. Perform a midline incision from the angle of jaw down to the manubrium sterni.
2. Using the operation microscope, select a 1 cm long segment of the left external jugular vein without venous branches and isolate it microsurgically (Figure 1a). During the whole operation frequently apply 4% papaverin HCl solution and antibiotic solution (neomycin sulfate 5mg/ml) topically on the vessels and anastomoses to prevent vasospasm and local infections.

 

3. Ligate the vein proximally and distally with 4-0 polyfilament sutures (Vicryl, Ethicon Inc, New Jersey, USA), then resect it and keep it in heparinized saline (1000 IU heparin in 20 ml 0.9% saline and 1 ml 4% papaverin HCl ).

## 3. Preparation of both common carotid arteries (CCAs)

1. Prepare a segment of the left CCA reaching from the carotid bifurcation down to the aortic arch. Preserve as far as possible arterial branches running medially and supplying laryngeal and tracheal structures as well as all neural structures.
2. Prepare the right CCA. Mobilize it up to the carotid bifurcation and down to the bracchiocephalic trunk.
3. Administer 1000 IU heparin intravenously.
4. Clip the right CCA temporarily just below the carotid bifurcation.
5. Ligate the right CCA proximally directly above the brachiocephalic trunk. Cut the right CCA above the ligature and irrigate the stump with heparinized saline.
6. Cut and resect carefully the adventitia at the free end of the right CCA. Free meticulously the segment of the left CCA planned for the anastomosis of the adventitia and clip it distally and proximally.

## 4. Anastomosis of both CCAs

1. Perform an elliptical arteriotomy of the left CCA between the clips according to the size of the planned anastomosis with the right CCA and the venous pouch. Irrigate the left CCA with heparinized saline. (Figure 1b)
2. Suture the posterior circumference of the right CCA-stump into the arteriotomy of the left CCA, using four to five non-resorbable 10-0 monofilament sutures (Ethilon 10-0, Ethicon Inc, New Jersey, USA).
3. Make a longitudinal cut in the stump of the right CCA to adapt to half the circumference of the venous pouch. Anastomose the back side of the venous pouch wall first with the arteriotomy in the left CCA, using again 4 to 5 10-0 sutures. Then anastomose the back side of the venous pouch with the backside of the right CCA with 3 to 4 sutures. (Figure 1c)
4. Perform the anastomosis in the same order at the anterior side. (Figure 1d)
5. Remove the distal clip on the right CCA. The aneurysm is usually not completely sealed, therefore wash trapped air and debris out.
6. Seal the suture lines around the anastomosis and the aneurysm neck with a fat pad and fibrin glue (Evicel, Ethicon Biosurgery Inc., New Jersey, USA). Remove the remaining clips.
7. Use 4-0 resorbable sutures (Monocryl,Ethicon Inc, New Jersey, USA) for interrupted subcutaneous sutures and then for a running cutaneus suture.

## 5. Postoperative management

1. Administer 10 mg/kg acetylsalicylic acid intravenously, and 60 ml 5% glucose subcutaneously.
2. Apply transdermal fentanyl matrix patches releasing 12.5 µg/hour in the shaved neck region of the animals for effective analgesia during 72 hours.
3. Administer 250 IU/kg low molecular heparin daily subcutaneously for 2 weeks.

## 6. Representative Results:

If the procedure is done correctly, the aneurysm will stay patent and the animals will recover within about 3 days. In our experience an imaging procedures should be done at minimum one week later. Otherwise the animals possibly won't tolerate the procedure and could be lost. For embolization we would recommend to wait for about 4 weeks to guarantee complete endothelialization of the aneurysm neck.Using the presented techniques and management the authors could reach aneurysm patency in 85.7% and no mortality in their recently published series.[14] To minimize the high rate of reported intestinal complications of up to 20%,[12] we provided a prolonged postoperative analgetic management of 72 hour analgesia as compared to routine 24 hour analgesia.This intensified management resulted in no gastric complications. The aggressive anticoagulation management is important to reach sufficient aneurysm patency rates. This goes along with the findings of Grunwald *et al*. showing the positive effects of combined anticoagulation.[17] Because of the aggressive anticoagulation it is crucial to have an effective sealing of the anastomosis. We made very good experience using new fibrin glue (Evicel, Ethicon Biosurgery Inc., New Jersey, USA). Additionally we recommend using small rabbits (maximum 3.5 kg), as in our experience complications are often related to overweight subjects.

## Discussion

The authors recommend to considerate the following critical surgical key steps to achieve good results and patent aneurysms:

1. Careful dissection of a long segment of the left CCA for easy anastomosis without destruction of nerves and small vessels.
2. Careful removal of the highly thrombogenic periadventitial fibrous tissue prior to the creation of the anastomosis.
3. Creation of a tensionless anastomosis.
4. Fewer sutures: The proposed sequence of anastomsis sites beginning at the back side gives better control of these most difficult sutures as compared to previous proposed procedures.[12,13,18]
5. Sealing of the suture lines using a fat pad or even better a fibrin glue (Evicel, Ethicon Biosurgery Inc., New Jersey, USA). With this sealing technique we reduced the number of sutures from 32[12,13] to an average of 23. This leads to shorter clamping times of both CCAs, with reduced neurological deficits and results in shorter overall operation times with reduced anesthesiological risks. Furthermore, a reduced number of sutures means less injury of the vessel intima, minimizing the risk of aneurysm thrombosis or embolism.
   The main drawbacks of the bifurcation aneurysm model can be overcome applying these techniques and management strategies. The patency rates ad morbidity/mortality rates are now equivalent to the actually most widespread aneurysm model, the elastase model.

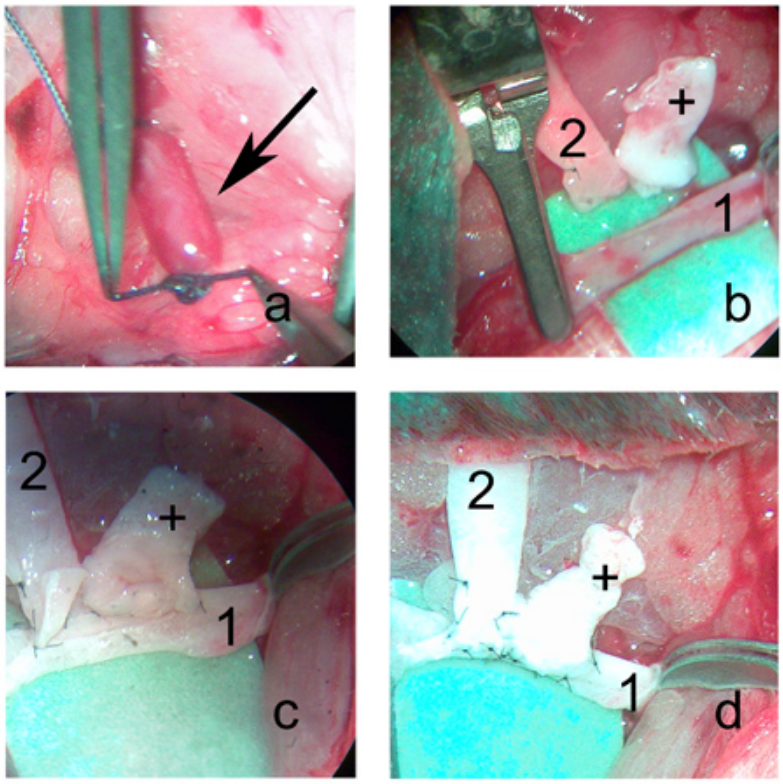


**Figure 1**. Intraoperative microscopic photos.

a. Isolation of the external jugular vein(arrow)
b. The left CCA (2) and the venous pouch (cross) are placed beside the proximally and distally temporarily clipped right CCA to define the length of the elliptical arteriotomy
c. The anastomsis is performed at the backside.
d. Final view of the completed anastomsis

## Disclosures

No conflicts of interest declared.

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