Creation of Aortic Dissection Model in Swine

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The use of mongrel dogs for experimental purposes was recently restricted and this report presents the experience of creating an aortic dissection model in swine. All the swine in group 1 were anesthetized without pentobarbital and the descending aorta was side-clamped during the creation of the aortic dissection. The false lumen of the completed dissection was patent in the long term despite not having the anchoring suture that the previous canine model required to stabilize the opening of the entry tear. All the swine anesthetized with pentobarbital (ie, group 2) died of heart failure either during cross-clamping of the descending aorta or postoperative aortography. In conclusion, creation of a thoracic aortic dissection is possible in swine, but cross-clamping of the thoracic descending aorta and pentobarbital anesthesia should be avoided. (*Jpn Circ J* 2000; 64: 736–737)

Key Words: Aortic dissection; Experimental model; Swine

Mongrel dogs have been the standard animal used for the experimental aortic dissection model, but recently their use has been restricted by a recommendation from the Society for the Prevention of Cruelty to Animals. We report the modified procedure and pitfalls in the creation of an aortic dissection model in swine instead.

Animals

A total of 12 swine, weighing 26–36 kg, were divided into 2 groups and their care complied with the 'Principles of Laboratory Animal Care' and the 'Guide for the Care and Use of Laboratory Animals' (NIH Publication No. 86-23, revised 1985).

Procedures

In group 1 (n=7), the swine were premedicated with intramuscular ketamine 10 mg/kg and atropine 0.03 mg/kg, according to advice that atropine should be given at a higher dose than in the group 2 swine (Dr KC Wright, personal communication). After anesthesia was induced with 4% isoflurane by mask, either endotracheal intubation (n=3) or tracheostomy (n=4) was performed. Anesthesia was maintained with 2–3% isoflurane. The thoracic descending aorta was exposed by posterolateral thoracotomy at the left fifth intercostal space, after which manual ventilation was performed. The descending aorta was side-clamped and incised transversely along 30% of its circumference. The aortic wall of the distal margin of the aortotomy was dissected in the middle layer. The incision was then closed by suturing the dissected outer layer and the proximal margin of the aortotomy using 6-0 Prolene in an 'over-and-over' pattern. The dissected flap of the entry was not anchored. The side-clamp was removed. Aortic clamp time was about 10 min. Immediately after the sutured site was rubbed by hand to widen the artificial tear and the false

lumen extended to the distal aorta. (Details of the procedure are shown in Fig 1.) This procedure was done without any inotropic agents or heparin. Aortography was done within 3 h of creating the aortic dissection. In the swine with a tracheostomy, the tracheostomy site was left unsutured.

In group 2 (n=5), the swine were premedicated with intramuscular ketamine 10 mg/kg and atropine 0.02 mg/kg. After anesthesia was induced with 4% isoflurane by mask and slow intravenous injection of pentobarbital 5 mg/kg, either endotracheal intubation or tracheostomy was performed. Anesthesia was maintained with 1–2% isoflurane, a lower concentration of isoflurane being used because of the pentobarbital induction. Thoracotomy and creation of aortic dissection were performed in the same manner as in group 1, except that the descending aorta was cross-clamped in 3 swine and side-clamped in the remaining 2.

Group 1

Despite the lack of an anchoring suture of the dissected flap of the entry, aortography revealed aortic dissection in all swine (Fig 2), and the dissection extended into the abdominal aorta in all except one. Two of the 4 swine that had a tracheostomy died of pneumonia 5 and 14 days, respectively, after creation of the aortic dissection, and although the other 2 swine also suffered from pneumonia, they died from rupture of the false lumen 5 and 20 days, respectively, after creation of the dissection. None of the 3 swine that were intubated suffered from any respiratory complications. One of these 3 swine died from rupture of the false lumen 8 weeks after its creation, but when the remaining 2 swine were sacrificed 12 weeks after creation of the dissection, the false lumen was fully patent in each.

Group 2

The 3 swine that had cross-clamping of the proximal descending aorta died of acute left heart failure caused by the rapidly increased afterload. The 2 swine that had side-clamping of the descending aorta tolerated the procedure of creating the aortic dissection, but their postoperative condition was unstable and both died of heart failure during aortography, which did reveal aortic dissection in both these swine.

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Fig 1. The thoracic descending aorta was (A) side-clamped and (B) incised transversely along 30% of its circumference and the aortic wall of the distal margin was dissected in the middle layer. (C) The aortotomy site was closed by suturing the dissected outer layer and the proximal margin of the aortotomy. (D) After removal of the side-clamp, the aortotomy site was rubbed by hand to widen the tear.

Since the report of Blanton et al,¹ the combination of mongrel dog, pentobarbital anesthesia and cross-clamping² of the descending aorta was the usual thoracic aortic dissection model. However, the use of mongrel dogs for experimental purposes has been restricted and although beagle dogs were recently used for an experimental thoracic aortic dissection model,³ they are expensive. Therefore we used swine, but some modifications of the procedure are required. All the swine anesthetized with pentobarbital (group 2) died of heart failure, despite the slow infusion and low dosage. Although pentobarbital is used as an anesthetic for swine during less invasive surgical procedures, it is a cardiac depressant⁴ and we suggest that even at low dosages it is not suitable for use in swine for the creation of a thoracic aortic dissection. As well, cross-clamping of the proximal descending aorta is itself extremely stressful for the swine heart. In 3 swine of group 1 (anesthetized without pentobarbital), we trialled cross-clamping of the descending aorta before making the incision, but the heart dilated and the heart rate decreased within a few minutes. Immediately after removal of the cross-clamp, the heart wall motion improved.

The previous canine model of aortic dissection required an anchoring suture of the dissected flap of the entry in order to stabilize the opening and ensure that blood entered.^{1,5,6} However, we did not use this procedure in the swine and creation of the thoracic descending aortic dissection was successful in all those swine that tolerated the surgery, and the false lumen was patent in all swine that survived long term (12 weeks postoperative). We believe that rubbing the initial dissected site to widen the tear

Fig 2. Aortography confirmed the aortic dissection, which extended into the branching portion of the celiac trunk of the abdominal aorta. T, true lumen; F, false lumen.

contributed to the extent of the false lumen and its patency in the long term. Our modified procedure requires no anchoring suture of the flap, and is better for interventional radiology studies or surgical treatments.

No inotropic support was required and blood pressure during the procedure was 100–140 mmHg.

In group 1, all swine with a tracheostomy suffered from pneumonia, but all the swine that were intubated were free from respiratory complications. Therefore, tracheostomy should be avoided.

In conclusion, the creation of a thoracic aortic dissection in swine is possible without the need for an anchoring suture of the artificial entry. However, we recommend that cross-clamping of the descending aorta and pentobarbital should not be used.

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