Experimental models in large size animals for devices in vascular pathologies

Pantaleo A.[1], Di Tommaso L.[1], Monaco M.[1], Castaldo S.[2], Di Napoli D.[2], Corona M.[2], De Martinis C.[2], De Marinis P.[3], Cozzolino S.[2], Iannelli G.[1]

[1]Department of Cardiosurgery , University of Naples “Federico II”
[2]Center of Biotechnologies, Antonio Cardarelli Hospital
[3]Functional Neurosurgery , Antonio Cardarelli Hospital

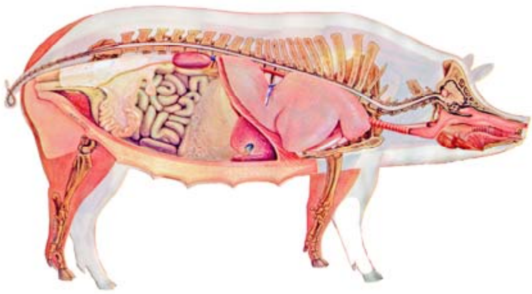
Background

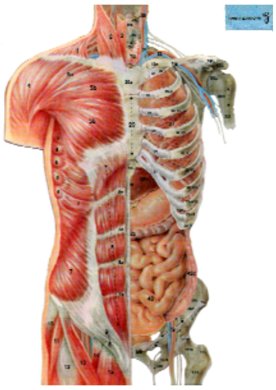
Biotechnology Center A.O.R.N. “A. Cardarelli” in Naples is equipped with experimental animal laboratories for research, and training in surgery and microsurgery, through ministerial authorization.

These laboratories developed and tested large animal models for bio-medical and pre-clinical studies. Pre-clinical experiments with animal models that closely match human morphology, physiology and genetic variability provide data that can easily be transferred to humans. On anatomical-functional grounds, there are many analogies between swine and humans.

These reasons have driven many investigators to seek these animals for different fields of preclinical research. The circulatory system is particularly similar to man and therefore readily adaptable to experimentation in the field of cardio-vascular surgery.

The experience gained by the staff at the Biotechnology Center has been significantly important in laying the scientific and cultural foundation for fruitful collaboration with researchers and scientific companies. This is seen with the development of four different models: 1) atrial-aortic cannulus for surgery on aortic valves in a beating heart; 2) prostheses for aortic arch aneurisms; 3) The use of devices for carotid aneurisms by digital angiogram 4) The use of devices to resolve carotid thromboses.





Materials and Methods

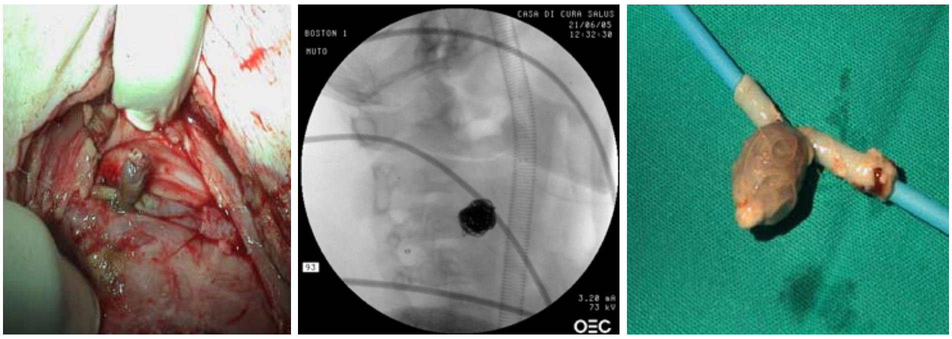
1) The experiment was performed on pig models in a pre-clinical study of cannulus use for surgery on the aortic valve and ascending aorta. This cannulus allows oxygenated blood within the left atrium to arrive in the ascending aorta without passing through the left ventricle. This allows the surgeon to operate on the ascending aorta while the heart is beating, thus avoiding extra corporeal circulation. The aim of the project is to increase the aortic valve surgery in patients in advanced age, so to prolong their life prospect.

Swine aortic ostium and semilunar valve

2) Aiming to resolve the problems linked to extra corporeal circulation in conventional surgery and to the hybrid two-phase treatment (consisting in a preventive revascularization of epiaortic or visceral vessels, followed by endovascular treatment) a new prosthesis has been designed that may allow us to:

- Treat aortic arch or thoracic abdominal aneurisms with one operation, by conventional surgery (sternotomy or thoracic-phreno-laparotomy);
- Avoid aortic clamp, extra corporeal circulation, deep hypothermia and the need for selective cerebral or vascular perfusion;
- Resection the aneurism wall, with intraoperative monitoring of bleeding and the perfect adhesion of the prosthesis.

3) An experimental human carotid aneurism model was made by creating a closed-lateral anastomosis. This procedure foresaw the use of a graft of the external jugular vein. This section divided into two parts, each of desired length is clamped at one end and anastomosed to the common carotid at the other end. The differet elastic component of the giugular, in comparison to carotid artery, allow the vein graft to puff up and simulate an artificial aneurism. This kind of tecnique permitt to realize different kind of aneurismes by size and conformation. Later an experimental device was inserted into the femoral artery, in which previously was created an access, to reach and to set right the aneurism. The entire experiment was performed by using an angiograph. This model is reliable and repeatable. It provides endovascular and embolus skills using of state-of-the-art materials. In addition, this experimental model will be able to be used to develop new patented devices.



Artificial carotid aneurism in three steps of the experiment

4) An experimental model was made for a new arterial device to resolve thromboses in the medial cerebral artery. In the animal model used a surgical incision was made for femoral artery access. Later was performed two techniques to simulate a thrombus: first we made an *in-vivo* thrombus doing an injection of bovine thrombin and barium sulphate directly on internal carotid which was pre-clamped, after 2 hours the thrombus was ready to get operate. In second approach an *in-vitro* thrombus was created using homologous blood with added bovine thrombin and barium sulphate. This was inoculated into the femoral artery until reaching the common carotid artery where the thrombus was positioned. The entire experiment was followed by angiography. Once reaching the zone with the device, using the femoral access, the thrombus was

penetrated. Dilation of the device crushed the thrombus against the walls of the vessel allowing blood to pass through the artery once again and restoring the flow.

Conclusions

The swine results to be an animal model realy reliable for the testing of new devices and for training new techniques. Overcoming the difficulties encountered with these devices, in the study they have been achievable in an anatomically complex animal, with optimism we look forward to their use in a simpler vascular structure such as in man.

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