

Chronic Intravascular Catheterization in Swine: General Principles

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Insertion of intravascular catheters for administration of test substances and withdrawal of blood samples is one of the most common surgical procedures performed in research. Comprehensive reviews of the subject, specific to swine, have been published.^{1,2} This manuscript provides a practical guide to general principals involving surgical implantation and maintenance of chronic intravascular catheters in swine.

Surgical Procedures

The most common sites of peripheral intravascular catheterization in swine are: auricular artery and vein, external and interior jugular vein, carotid artery, cephalic vein, femoral artery and vein, medial saphenous artery. Internal sites include: pulmonary artery, vena cava, hepatic artery and vein, portal vein, renal artery and vein, aorta, internal and external iliac artery and vein. In depth techniques for the surgical catheterization of these blood vessels have been described.¹ Regardless of the site, it is important that the tip of the catheter be in a high flow, turbulent area and that the tip not be in contact with a vessel wall to help prevent thrombosis. It is beyond the scope of this manuscript to completely describe the techniques.

Catheter Design

Many problems can be minimized by proper catheter design, which avoids traumatizing the vessel walls, thus, initiating a thrombogenic response or erosion. For most procedures biocompatible silicone or polyurethane catheters are appropriate, although other materials such as polyethylene, teflon or polyvinyl chloride may sometimes be indicated. Silicone has the advantage of being soft, flexible, atraumatic and autoclavable, although it is porous and is more difficult to insert than materials which are more stiff. Polyurethane is firm and easy to insert, but it is more traumatic to blood vessels and is not autoclavable. Tips of the catheters should be tapered and have smooth rounded edges. Part of the length of a silicone catheter can be partially covered with polyurethane to give stiffness to the body of the catheter and avoid kinking. Careful handling of silicone to prevent absorption of contaminants such as tissue glues, which can be toxic, should be ensured. It is best to purchase manufactured catheters rather than try to make them in the lab to avoid these issues. A variety of implantable port devices are available to avoid having to exteriorize the catheter from the skin.³ These require special needles and placement techniques, but have the advantage of reducing risk of infection to exit sites. They may also be sutured onto the surface of the skin.¹

Principles of Surgery

The general principles of surgery apply to these procedures. They are: asepsis, closure of dead space, hemostasis, gentle handling of tissues, careful approximation of the wound, avoid wound tension, minimize foreign material. In addition there are specific principles that apply to the implantation of catheters: immobilization of the catheter, an atraumatic tunneling pathway, secure the exit site, antibiotic prophylaxis at the time of surgery and use of anticoagulant therapy.

It is very important to immobilize the catheter at the site of insertion into the blood vessel and at the site of exit from the skin. This can be performed by leaving a coil of the catheter subcutaneously and putting a sc pursestring suture around the catheter before closing the skin. At the exit site the catheter should have a cuff which allows tissue ingrowth or fibrosis around it to ensure a permanent seal against infection. Antibiotic prophylaxis is not a

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substitute for aseptic technique. The blood level of antibiotic that is present at the time of the skin incision is the most important dose if such therapy is indicated. Long term administration is not necessary unless contamination has occurred.

Swine also have species-specific considerations: do not use silk or gut sutures, be aware of their behavioral characteristics, exteriorize catheters from the dorsum, use protective devices to prevent damage to the exteriorized catheter. Silk and gut sutures tend to be inflammatory in swine and can lead to seromas and infection. Swine rub themselves against their cages and do not chew or scratch their incisions with their feet. Consequently, catheter exit sites should be on the dorsum of the body. Canvas or plastic coverings and/or protective vests can be put on swine to prevent trauma to the catheters. Swine of the same breed and age tend to have the same measurement from the catheter insertion point to the site of interest for the tip of the catheter. Therefore, catheters can be manufactured in advance with suture retention beads fixed in place. (Figure 1,2)

Catheter Maintenance

Anticoagulant therapy is necessary to prevent blood from clotting within the catheter. Catheters which are used for continuous infusion do not need anticoagulation, but an infusion rate of 2-3 ml/hr is necessary to prevent coagulation. Systemic coagulation is not required for intravascular catheters.

No consensus exists on a postoperative protocol for every type of intravascular catheterization. However, some principles utilized by our laboratories have proven effective for long term catheter maintenance. It is essential to use complete asepsis with iodine preparation of the catheter and use of sterile gloves to handle an implanted catheter. At the time of implantation, the volume of the catheter should be determined and the correct amount of 1:1000 heparin be injected into the catheter. Flushing of the catheter is necessary every time it is accessed or 1-2 times per week when it is not being accessed for sample administration and collection. The procedure is to withdraw all the old heparin until blood is visualized, flush copiously with saline and then reinject the predetermined amount of heparin required to fill the catheter.

More detailed information is available in the references,^{1,2} however, this synopsis is meant to be a guideline for the principles of intravascular catheter design and maintenance for swine used in research.

Selected References

1. Swindle MM: Surgery, Anesthesia and Experimental Techniques in Swine, Ames, IA: Iowa State University Press, 1988.
2. Swindle MM, Smith AC, Goodrich JA: Chronic cannulation and fistulization procedures in swine: A review and recommendations. *J Invest Surg* 11: 7-20, 1998.
3. Buyer's Guide 2003, *Lab Animal* 31(11): 69, 2002.