Catheterization Series

Nonsurgical Vascular Catheterization Techniques in Swine

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Introduction

Collection of blood and intravascular administration of test substances is one of the most common procedures required in preclinical trials of therapeutic agents. Comprehensive descriptions of the various IV sites and the surgical approaches for chronic catheterization have been published.[1] These methodologies include the implantation of SC vascular access ports as well as externalized catheters. Summaries of these surgical techniques are available in a series of manuscripts on this website.[2]

For short to midterm vascular catheterization it may not be desirable or necessary to perform surgical implantation of catheters. It is possible to catheterize some of the peripheral vessels and maintain patency for up to 10 days. However, as a general rule many of these techniques can only assure a reasonable percent of success for approximately 3-10 days. The purpose of this manuscript is to provide a description of some of the techniques of short term catheterization which have been successful in the author's experience.

Aseptic Technique and Restraint

A key issue with maintaining patency and preventing complications is the absolute use of aseptic technique both during the catheterization and the sampling procedures. It may be difficult to perform aseptic insertion of the catheters in an unanesthetized animal. If sedation is not contraindicated by the protocol then a variety of injectable or inhalant techniques may be utilized and are available in the references.[1, 2] Injectable agents which can be recommended for short term chemical restraint include ketamine, acepromazine, diazepam or midazolam either as sole agents or as combinations. Administration of isoflurane or sevoflurane via a face mask is another reliable method for short term restraint. If anesthetics are contraindicated pigs may be trained to be restrained in slings for some of the procedures. However, this method is probably most reliable for administering test substances and collecting blood samples.

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Figure 1. The double lines illustrate the path of the external jugular vein. The dot at the apex of the triangle is a reliable site for insertion of a central venous catheter

Types of Catheters

There are many types of commercially manufactured catheters that can be used for these procedures. Although silicone catheters are the preferred types for surgical implantation, polyethylene or polymer catheters would be the preferred type for non surgical catheterization of peripheral vessels. The author's preference of catheters is listed below:

- Jelco® Cathlon FEP polymer, Smiths Medical ASD, 14-24 g, .75-2.25 in long.
- Terumo® Surflo Teflon, Terumo Medical Products, 14-24 g, .75-2.5 in long.
- Intracath® Central Venous Catheter, BD Worldwide, 16-22 g, 8-24 in long.

Peripheral Vessel Catheterization

The veins which are most usable for chronic catheterization are the auricular, cephalic (subclavian), external jugular, cranial vena cava (precava) and mammary (cranial epigastric). Although there are other peripheral veins these are the most reliable for the techniques described in this manuscript. 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. All of the veins require that the catheter be filled with a premeasured amount of heparin.

Auricular Vein: The veins on the periphery of the ears are the primary site for catheterization for many procedures. For chronic catheterization the use of Jelco® or Terumo® catheters is preferred. Application of alcohol to the ear will dilate the veins and improve visibility. If the vein is going to be chronically catheterized then iodine solution is also applied to the ear. An assistant should put manual pressure at the base of the ear in the area where the vein enters the neck musculature. It is recommended that the needle be inserted into the skin to the side of the vein rather than directly over the vein. This provides additional security for holding the needle in place. The vessel is catheterized in the usual manner and taped in place with a roll of gauze in the inner fold of the ear to provide stability. A heparinized catheter inserted in this manner is usually only patent for a maximum of three days.

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Figure 2. An Intracath (catheter through needle) is being inserted into the auricular vein

External Jugular Vein: The external jugular vein in large and deep in the tissues of the neck at the level of the ventral surface of the cervical vertebrae. It is the largest of the peripheral vessels and can be accessed through the jugular furrow between the sternocephalic and brachiocephalic muscles. The jugular furrow is visualized when the pig is in dorsal recumbency with the foreleg pulled caudally. The vein runs along a line from the medial aspect of the mandible to the thoracic inlet. An imaginary triangle may be visualized with the base at the thoracic inlet and the apex over the vein. This site is the best location for accessing the vein (Figure 1). The catheter should be advanced into the precava but not beyond the third rib which is the level at which the base of the heart is located. Passing the catheter into the heart will produce arrhythmias. After heparinization the catheter can be attached to the skin with suture and a circumferential bandage passed around the neck to protect it. Catheterization at this site can usually be maintained for up to 10 days.

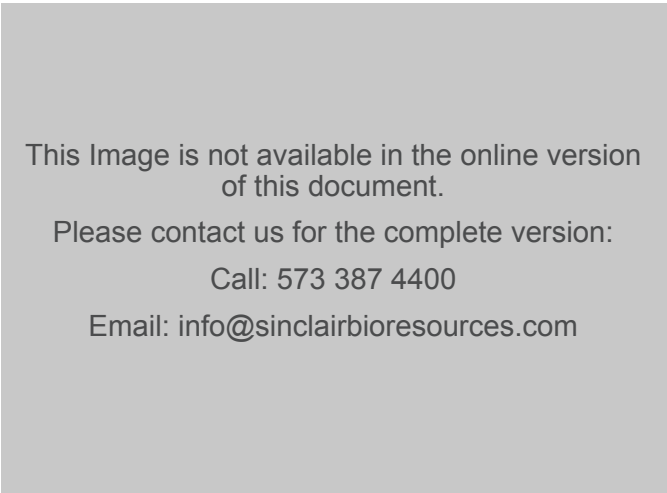

Figure 3. The Intracath insertion is completed and the protective cover is removed from the catheter

The external jugular vein can also be catheterized via the auricular vein in pigs which have a relatively straight vein with few curves or side branches (Figures 2-4). With this technique an Intracath is inserted into the auricular vein and the catheter passed through the needle to the level of the entrance of the vein into the neck muscles. At this point digital pressure is applied to ease the entrance of the catheter into the dorsal mandibular branch of the external jugular vein. After the catheter is passed into the main portion of the vein it is secured to the ear in the same manner as for the auricular vein bandage described above. Catheterization of the vein in this manner can usually provide continued access for up to 5-7 days. The usual cause for failure is kinking of the catheter within the neck muscles.

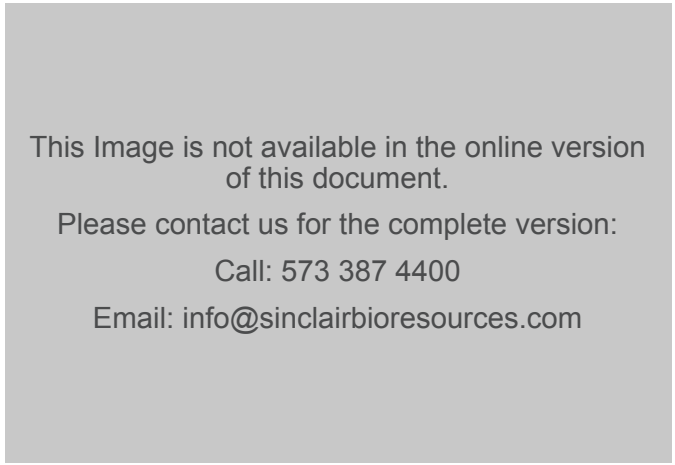

Figure 4. The ear is wrapped for protection and an IV infusion has been started

Cranial Vena Cava (Precava): The cranial vena cava can be chronically catheterized by passing the Intracath® or other suitable catheter into the vessel through the right side of the thoracic inlet. The right side is used to prevent accidental stimulation of the recurrent laryngeal nerve which can result in a fatal cardiac arrhythmia (Figure 5). Care should be taken to not pass the catheter into the right side of the heart which can also result in arrhythmias. The base of the heart is located at the third rib and this distance should be used to measure the proper length of the catheter to be used. When passing the needle into this vessel the needle should be angled approximately 45º to the neck and passed towards the left elbow. Large volumes of blood can be obtained from this vessel with ease. The catheter should be attached to the neck with suture and/or a circumferential neck bandage to prevent dislodgements. Catheterization of this vein can usually be kept patent for up to 14 days.

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Figure 5. An Intracath is being inserted into the cranial vena cava through the right thoracic inlet

Cephalic (Subclavian) Vein: The cephalic vein courses along the cranial aspect of the radius and then courses over the humerus, across the neck and into the thoracic inlet (Figure 6). At that point it enters the external jugular vein close to its anastomosis with the precava. In animals with a clavicle this portion of the vein correlates to the subclavian vein. By applying digital pressure in the thoracic inlet and applying alcohol to the area the vein can be readily visualized. This vein is superficial and only covered by the cutaneous muscle. An Intracath® can be passed in to the precava through this site. A catheter passed this way has to be sutured to the skin. A circumferential neck bandage cannot be made to cover this access site because it is too caudal. A clear adhesive patch bandage can be applied over it to prevent contamination and dislodgement. This usually can be kept patent up to 14 days.

Catheterization of the cephalic vein over the foreleg provides only short term access of approximately 1-2 days because of the small size of the vein in that region. It can be bandaged in place with a circumferential bandage around the leg.

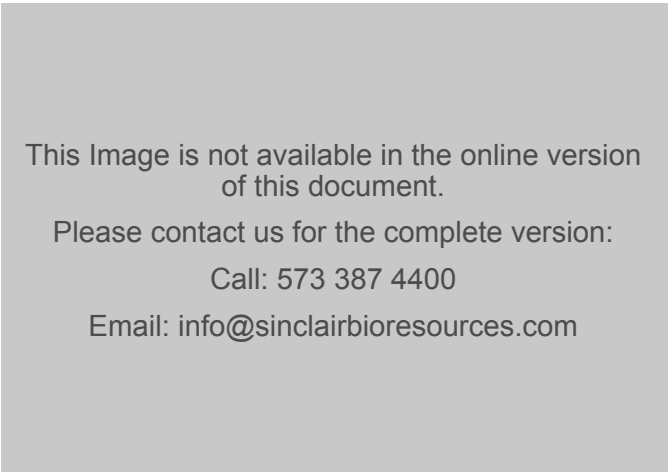

Figure 6. The cephalic (subclavian) vein position is illustrated with a single blue line on the right side. For comparison the external jugular vein outline is illustrated on the left side of the neck

Cranial Epigastric (External Mammary) Vein: The cranial epigastric vein courses along the lateral edge of the first three mammary glands (Figure 7). It is superficial and may be covered by a portion of the mammary gland in older animals. Putting digital pressure at the juncture of the mammary gland and the caudal thoracic entrance will allow dilatation and visualization of the vein. The vein becomes the internal thoracic vein after that level. This vein can be substantial in size in sexually mature animals but is approximately the size of the cephalic vein in young animals.

The vein may be catheterized with any of the recommended catheters but must be sutured to the skin to prevent dislodgement. A circumferential bandage around the abdomen is necessary to protect the catheter. In smaller animals the period of patency is relatively short. However, in more mature animals the catheter can be maintained for up to 14 days.

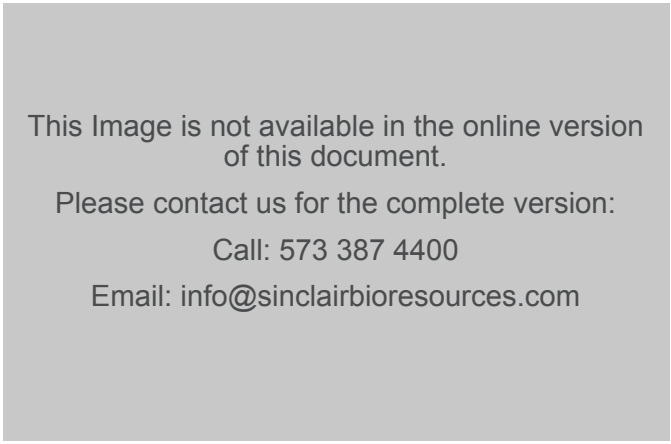

Figure 7. The course of the cranial epigastric (mammary) vein is illustrated with a blue line. The head is towards the left

Catheter Maintenance

Anticoagulant therapy is necessary to prevent blood from clotting within the catheter. Systemic coagulation is not required for intravascular catheters. No consensus exists on a postoperative protocol for every type of intravascular catheterization. However, it is essential to use complete asepsis with iodine preparation of the catheter and use of sterile gloves to handle vascular catheters. 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. The procedure requires withdrawal of all the old heparin until blood is visualized. The sample may then be collected or the test

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substance administered. The catheter is then flushed copiously with saline followed by filling the catheter with the predetermined amount of heparin required to fill the catheter.

It is possible in one animal to access more than one vein if a catheter fails. Thus it is possible to provide long term catheterization by rotating sites.

Selected References

1. Swindle MM: Surgery, Anesthesia and Experimental Techniques in Swine, Ames, IA: Iowa State University Press, 1988.
2. Sinclair BioResources Website: http://sinclairbioresources.com/Literature/Literature.aspx

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