Repeated jugular catheterization of Göttingen Minipigs using ultrasound

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Introduction and objective

As serial infusion and blood sampling are often important technical aspects of an experimental design, vascular access is a prerequisite. Compared to other laboratory species such as the dog or rabbit, superficial veins in the pig are not readily accessible. Although the minipig has a convenient size for handling, restraint and venipuncture can be stressful and affect blood parameters. As stress hormones has profound impact on glucose metabolism, non-stressful blood sampling is especially important in relation to this type of study. Therefore, when experiments require frequent blood sampling, catheterization is the best option, both ethically and scientifically. Ear veins in the domestic pigs are the most readily accessible peripheral vessels and are a suitable option for catheterization. But studies have shown, that even after a short period of implantation, catheters can cause intimal hyperplasia that encroaches on the vessel lumen and causes stenosis, making reuse of the ear vein impossible, unless the replacement is carried out immediately after removal of the original catheter. Another common site for catheterization is the jugular vein. However, establishing a venous access via the jugular vein percutaneously, can be challenging in the pig due to abundant subcutaneous fat and deep localization of the vessels. Venipuncture of the jugular vein is therefore a blind procedure, with a risk of puncturing important structures such as nerves or arteries. In study designs where the need for intravenous (IV) access is limited to shorter periods during the entire study, it could be relevant to avoid permanent IV catheters. This will eliminate the risk of catheter-related complications and furthermore allow group-housing.

We propose a safe and reliable alternative method for implanting jugular catheters in minipigs using ultrasound guidance. The method is less invasive than the surgical approach and permits reuse of the same vessel. Shorter periods of catheterization can minimize the risk of complications seen in animals with permanent catheters and at the same time allow group housing during periods without catheters.

Materials and Method

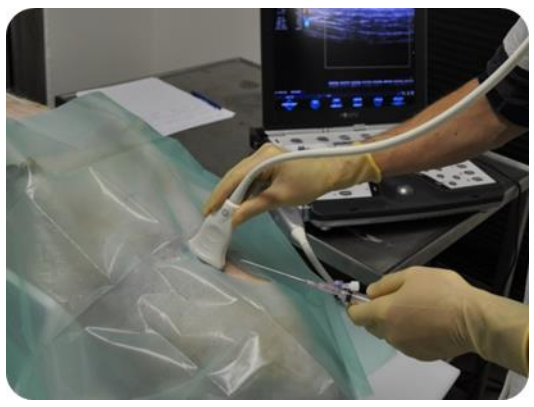

Fig. 1 After placing the anaesthetized pig in dorsal recumbency, a linear array transducer (13 MHz) is placed in the jugular groove. A 5mL syringe attached to a hypodermic valve needle is guided into the vein. It is important that the needle entry point (catheter exit point) is approximately midway between the mandible and the manubrium sternum, as this will facilitate the protection of the catheter with a bandage.

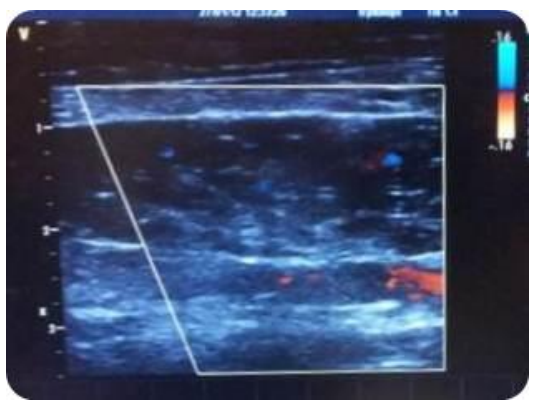

Fig. 2. The external jugular vein is located using 2D color-flow-Doppler.

Fig. 3 Vacuum is applied by retracting the plunger of the syringe, as the syringe/needle is advanced.

Fig. 4 Once blood appear in the barrel of the syringe the kink-proof guide wire with flexible J-tip is introduced through the valve needle's second laterally positioned Luer port. This port contains a valve that prevents any discharge of blood. As the guide wire is advanced into the vein, the valve needle and attached syringe can be retracted.

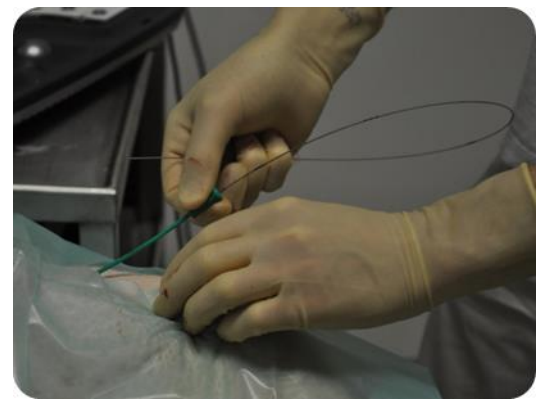

Fig. 5 A dilator is advanced over the guide wire until penetrating the skin, thereby facilitating percutaneous placement of a catheter. The dilator is removed and an antimicrobially coated double-lumen catheter (Certofix Protect Duo V730, BBraun) is advanced over the guide wire, until the desired length is inserted. The optimal position of the catheter tip is the junction between the right atrium and the cranial caval vein. The position can be verified by ultrasound or x-ray.

Fig. 6 A round protective disk impregnated with chlorhexidine gluconate (Biopatch®, Ethicon) is applied to the skin around the catheter at its exit point. A fixation wing is applied for securing of the catheter be means of polypropylene sutures through the skin.

Fig. 7. The catheters are flushed with saline and filled with a lock solution. The external part of the catheter is protected by a collar made of elastic adhesive bandage.

Results

Eight Göttingen Minipigs were catheterized on a total of 18 occasions (2 animals on 3 occasions, 6 animals on 2 occasions). Weight range of the animals in the entire period was 10-34.9 kg. All catheterizations were carried out in the right side of the animal. Between 27 and 85 days elapsed between catheterizations. Catheters was removed after an average of 12 days (range 8-13 days). One catheter was removed prematurely as it had been damaged by the minipig housed in the neighbouring pen. During the periods of catheterization no episodes of infections were observed based on clinical signs and macroscopic evaluation. We found that central venous access can be established relatively easily using ultrasound guidance. With a little practice, the whole procedure; from the animal is surgically prepared until the bandage is applied, can be carried out by two persons in approximately 20 minutes. Although useful in the beginning when training, we found that a puncture guide were not needed during the procedure as working freehand offers greater flexibility.

Conclusions

This approach provides a safe and reliable method of puncturing deep veins, with minimal invasiveness. Furthermore this method can be deployed several times during a long term study, eliminating the need for permanently placed catheters and thereby decreasing the risk of catheter-related complications as well as the work load needed to maintain the catheters patent. From an animal welfare perspective, this approach allows group housing during periods when pigs are not catheterized, in line with the refinement principle of the 3R's.