

Role of simulator in surgical blood pressure

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Abstract

Every year, thousands of animals like rats, mice, cats, dogs and cold blooded experimental animals are sacrificed for the in-vivo, in-vitro pharmacological studies. Invasive technique like cannulation of blood pressure (BP) requires a good technical skill which can be developed after practicing on a large number of animals. Practice requires sacrificing many animals every time and the number can be substantially minimized by practicing on the models.

The BP simulation model involves actual cannulation like invasive rat BP. The model promotes the 3Rs (reduction, refinement, replacement) concept. The technique used is economical and user friendly and leads to development of skill without handling the animal. It can reduce the number of animals and also the animal suffering.

Keywords: model, simulation, cannulation, 3Rs, blood pressure

Introduction

3Rs in education and training

Although the concept of the 3Rs (reduction, refinement and replacement) proposed by William Russell and Rex Burch (Russell, Burch, 1959) was mainly intended to address animal use in research, there are many parallels to the use of animals in education and training. These parallels have resulted in legislation in many countries that grants animals equal protection whether they are used for biomedical research or for educational purposes. Russell and Burch made several predictions about alternatives in education, despite the fact that audiovisual aids were in their infancy in the 1950s when the 3Rs concept was emerging. They wrote, "The listing and distribution of films and filmstrips for demonstration may be an important mode of humane progress in teaching. Television, too, might be pressed into service here." (Russell, Burch, 1959)

Education is defined as the transfer of existing knowledge to improve the understanding of the anatomy, physiology and pharmacology of living systems. Training is defined as the learning and practicing of skills. (Valk et. al, 2000) As the technology in the field of Pharmacology is changing rapidly the learning process needs to be made simpler, faster, economical and safer. Developing such simulator based training models and incorporating

it in the curriculums of pharmacology education by health universities and industries to train their employees will definitely bring down the cost of the project and reduce the number of animals. (Gadgil, 2006)

Many of these products such "The heart of America series and the Rabbit ear venepuncture" simulators were developed in order to minimize the number of animals. They vary in their complexity, more advanced and serve as a model displaying detailed anatomy and pathological states. (Smith, 2004)

Cardiovascular disorders are one of the major lives threatening conditions causing a lot concern. A lot of basic research is going on in this area. Almost every investigational new drug and herbal origin compounds need to be screened for their effects on blood pressure (BP) which generally require invasive rat BP estimation. The method demands cannulation skill and once the experiment is over, the rats have to be sacrificed. Also in many universities the students are practicing and performing invasive rat BP experiments to get hands-on experience and improve their skills. For these reasons a lot of animals are used and sacrificed every year.

This simulated rat BP alternative is a 3D teaching and practicing model which may even replace animals to a certain extent and also help the students and researchers to reduce the number of animals

by improving their practical skill of cannulation. This alternative model can contribute to refine the procedure of cannulation by improving the students' dissecting skills leading to less number of mistakes (and subsequent pain and suffering in the animal).

Materials and methods

Invasive rat blood pressure

In invasive rat BP experiment, the carotid artery is cannulated for measurement of rat BP, Jugular or femoral vein is cannulated for administration of drugs. Cannulation is a critical step in the experimental set up and a model to simulate this step has been designed and constructed.

Simulation model for practicing cannulation in invasive rat BP

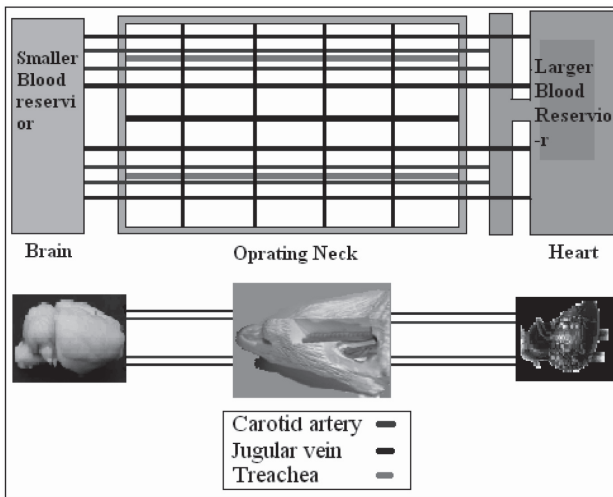


Fig. 1 Structural representation of model (Top view)

Features of the model:

- Larger blood reservoir simulates the heart of rat. It is made of plastic box. It is directly attached to jugular vein and carotid artery through one middle pipe. Carotid artery receives blood with pressure from motor outlet, which is present in larger blood reservoir.
- Smaller blood reservoir is the brain of rat. It is made of plastic box. Both carotid and vein directly attached to it.
- Middle plate is neck portion of rat. This is the main operating portion of the model. It is divided vertically into two and horizontally into five equal partitions. Each square represents neck portion one rat. There are totally 10 operating portions in a plate.
- Carotid artery and jugular vein are simulated using stretchable and elastic tubes. The diameter of the tubes corresponds to the actual diameter of rat artery and vein. (Sharp, 1998). Their depth from the surface of neck

and the distance from trachea and each other also correspond to the actual measurements in a rat.

- Motor is used to maintain the blood circulation by generating pressure in the larger blood reservoir.
- Skin, dermis, epidermis, smooth muscle's strength, thickness, softness, resealability properties are also simulated using appropriate material.

The actual model which is constructed is shown in Fig. 2.

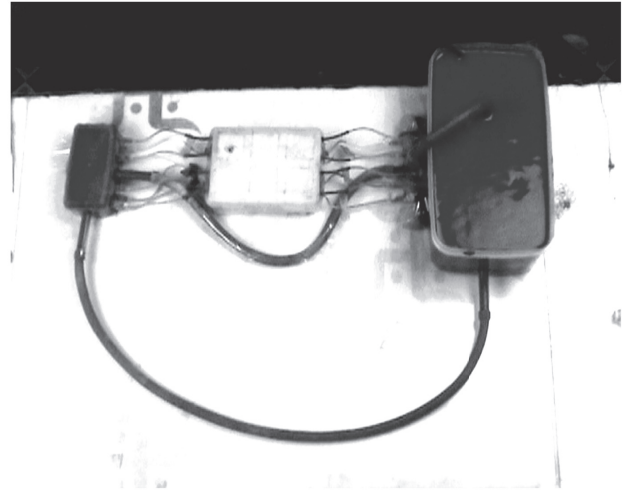


Fig. 2 Actual model

Discussion

Advantages of model

1. This model can be used to implement 3R concepts.
- **Reduction:** The simulator can reduce the number of animals used for practicing cannulation technique on live animals. Students can have their practice sessions on the model and later switch to live animals when they are confident.
- **Refinement:** During the practice sessions on the model the mistakes made by the students can be pointed out and corrected. The experience gained using the model will help the students apply proper dissection techniques on the live animals. This will cause minimal suffering to animals and avoid unnecessary repetitions.
2. Ten rats can be saved per plate. One plate containing 10 cells can be used for 10 sessions.
3. Cannulation of carotid arteries and jugular veins cannulation can be practiced 20 times on a single plate as each cell has 2 carotid arteries and 2 jugular veins.
4. Cost effective. The cost of 10 rats is very high as compared to the model.

5. By practicing cannulation on this model, better cannulation skill can be developed and the students can confidently perform the invasive BP experiment on live animals.

Conclusion

We believe the development of the model is a progressive step made towards the 3Rs in education and biomedical research. This model helps students and researchers to improve their practical skills by offering a simulated hands-on cannulation procedure. This is one of the constructive developments to satisfy scientific communities and animal protection groups.

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