ABSTRACT

Background: The rat femoral vein and dorsal penile vein have been have been well described as microvenous models. We report the use of the rat tail lateral vein as model for microvenous anastomosis training.

Methods: Careful anatomic dissections were made of the rat tail noting the basic gross anatomy in 3 rats. 20 albino rats were anaesthetised via intraperitoneal ketamine injection, lateral vein of the tail is then transected about 5 cm distal to the tail base. Immediate repair was carried out by standard interrupted microanastomosis suture technique with 10/0 nylon suture. Patency was assessed at 30 minutes and 1 week.

Results: 40 consecutive anastomosis of the lateral tail vein was done in 20 rats. The mean diameter of the rat tail lateral vein in the study rats was 0.8mm SD± 0.02mm. The mean anastomosis time was 22.6 minutes SD±4.3 minutes from clamp application to removal. There was a 90% patency rate at 30 minutes and 81 % at 1 week.

Conclusion: The rat lateral tail vein appears to be a viable alternate model for microvenous anastomosis. The study identifies the ease of access, duality, potentially long length and the absence of accompanying artery as some of the unique features of this microvenous anastomosis practice model.

Key words: Rat, tail , model, microvenous, anastomosis

Microvenous anastomosis: The rat tail model alternative

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Introduction

As microsurgical reconstruction becomes more widespread, there is increasing need to develop robust training models for various aspects of the basic microsurgical training course [1].

Microvenous anastomosis represents an important component of developing basic microsurgery skills. It is arguably more challenging compared to the arterial anastomosis [2]. Venous anastomosis often requires the trainee to more stringently apply the core principles of appropriate magnification, accurate haemostasis, gentle tissue handling all in an atraumatic setting. Venous problems are often the commonest cause of vascular problems following free flap surgery [3-5]. Competency in rat femoral vein anastomosis may be an indication of acceptable microsurgery competency. We decided to study the rat tail venous anastomosis model with regards to its value in basic microsurgery training.

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Methods

We studied 40 consecutive anastomosis of the lateral veins of the rat tail. Following Health research and ethics committee approval, 20 Sprague Dawley albino rats of both sexes were selected.

The study protocol was approved by the University animal ethics committee of the institution and the study was conducted in accordance with the internationally accepted guidelines, including the Universal Declaration of Animal Rights, European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes.

In three rats, anatomic dissections were done to determine the anatomy, external diameter, ease of dissection, presence or absence of any tributaries as well as drainage pattern and these were excluded from the venous anastomosis study. In the anastomosis group the animals were anaesthetized using intra peritoneal ketamine 0.15/kg divided into small doses administered at 45 minutes interval depending on the depth of anaesthesia.

The tail segment was shaved and a point 5cm from the coccyx was selected (Figure 1). With the animal in supine position a mid lateral incision was made on each side. Care was taken to avoid injury to the subdermal vein. A ventral transverse extension was often made along the ventral border of this incision to connect the 2 mid lateral incisions giving an H shaped incision. This improves access, exposure and eases mobilization of the mid lateral veins. Bipolar cautery was set low to avoid inadvertent injury to the vein during mobilization.

The veins were carefully dissected out and freed to expose about 2 cm of the length. The vessel was then cleared of adventitial carefully and observed to relieve vasospasm and confirm adequate flow.

Anastomosis was done under x 20 magnification using the conventional interrupted suturing technique. Flow was confirmed at the end of the procedure, 30 minutes later and at 1 week after repair.

Results

Anatomic study

The rat tail is often covered with a prickly hair. The subcutaneous tissue progressively thinner distally. In the midline ventral area, thick anterior sheath in between the lateral muscles encase the central artery of the tail (Figure 2). The commitantes vein accompanying this artery are often too small for anastomosis. The lateral veins are capacious and large often just subcutaneous and occasionally visible to the naked eye. It lies

Figure 1. Rat tail showing point of incision A.

Figure 2. A line diagram of the rat tail internal anatomy, (A) Dorsal Coccygeal muscle, (B) Lateral vein of the tail, (C) lateral coccygeal muscle, (D) coccygeal veterbrae, (E) Ventral fascia, (F) central artery of the tail.
adjacent to nerve fibres motor to the muscle of the tail. The blood supply of the skin is segmental and in order to adequately mobilize the lateral tail vein you need to carefully ligate the deep and cutaneous tributaries. We did not encounter any lateral vein calibre unsuitable for anastomosis.

**Anastomotic study**

The mean weight of the rats was 285gms. 40 lateral veins were anastomosed. The mean external diameter of the vein 5 cm distal to the coccyx was 0.8 mm SD± 0.02mm. The mean anastomosis time was 22.6 minutes SD±4.3 minutes from clamp application to removal. There was a 90% patency rate at 30 minutes and 81 % at 1 week.

**Discussion**

The rat groin is one of the most studied models for microsurgery training [6]. Microvenous anastomosis models have been described using rat femoral vein, external jugular vein and dorsal penile vein [7-9]. While the rat tail as a model for microsurgery training is not new [10-12]. The blood supply of the rat tail has also been well described [13]. The use of using the lateral vein as a practice model has not been previously explored to our knowledge. The uniqueness of the lateral vein of the rat as microvenous anastomosis model is being studied in this work. The lateral veins of the rat tail are large calibre and easily seen. the veins can occasionally be visible to the naked eye, located subcutaneously, with easy accessibility, it is commonly used for administering intravenous drugs in the laboratory rat. The dual nature of the vein creates abundant opportunity for microvenous practice unlike the femoral and dorsal penile vein model with limited lengths. It also allows for testing of an hypothesis on microvenous anastomosis because both experimental and control groups can be carried out on same rat tail. The ‘almost’ infinite length of vein available which makes it suitable for microsurgeons to choose the level of venous anastomosis tailored to a specific of level of difficulty unlike most of the other models (Figures 3,4). There are no surrounding arteries reducing the risk of accidental vascular injury and reducing mortality. This model offers a novice microsurgeon the opportunity of beginning again at more proximal level in cases of inadvertent injury. It may also be of value in training for supermicrosurgery as well as lymphatic vessel anastomosis on account of similar calibre vessels.

This model however is not without its disadvantages. The mid lateral nature of the vein makes it necessary
for the animal to be in the lateral position during surgery. The thin friable nature of the veins offers a significant challenge to the novice microsurgeon and there is clearly a learning curve in working with this vessel.

In spite of these limitations we are of the opinion that the rat tail models offers a practical alternative in microvenous anastomotic models for microsurgical training.

**Conflict of interest statement**

The authors have no conflicts of interest to declare. This study was funded by University of Lagos, Nigeria Central Research Grant CRC 2015/16.

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