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## Saphenous artery-based flap models in rats: new flap designs for experimental studies



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### ABSTRACT

**Background:** Experimental research using laboratory animals provides substantial data about reconstructive surgery. However, the literature does not include any experimental studies that have used flap models on the hind limbs of rats. To gain an understanding of the physiology of lower-extremity flaps and of flap failures, this study assessed the cutaneous perforators of the saphenous artery, and new flap models were designed for the hind limbs of rats.

**Materials and methods:** The experiment was designed to include three stages and used 35 rats. The first stage involved mapping the perforators of the saphenous artery. In the second stage, the contents and structures of McFarlane, epigastric, and anterior hind limb flap tissues were compared histologically. The third stage of the study involved designing and comparing different flaps for the hind limbs of the rats and included random flaps, perforator-based peninsular flaps, perforator-based island flaps, and perforator-based flaps with rotated pedicles. Postoperative necrosis ratios were evaluated using computer-based software.

**Results:** Mapping of the saphenous artery perforators revealed an average of 2.2 septocutaneous arteries in each hind limb. Histologic studies showed thick dermis and panniculus carnosus in the McFarlane flaps, thick dermis, and thin panniculus carnosus layers in the epigastric flaps, and thin subcutaneous tissue with no panniculus carnosus tissue in the skin of the hind limbs. The results of the flap studies that used random flaps showed a 52.4% necrosis, while there was no necrosis when perforator-based peninsular flaps, island flaps, and flaps with rotated pedicles were used.

**Conclusions:** New flap models used on the saphenous artery perforators of the hind limbs of rats can provide valuable information about the physiology of lower-extremity flaps. New studies can also be designed based on these flap models to acquire more knowledge about pathologic conditions such as ischemia and venous insufficiency.

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## Introduction

Flap surgery is the cornerstone of plastic surgery, and a thorough understanding of flap physiology is the key to the success of this surgery. Experimental flap models provide valuable information about reconstructive surgery. However, getting the targeted data from experiments are possible only when the correct laboratory animal and a suitable flap model are chosen. Rats are the most common laboratory animals used because of their availability, the low cost of acquiring and maintaining them, and their resistance to disease.<sup>1</sup> McFarlane *et al.*<sup>2,3</sup> and epigastric flaps are the flap models that are most frequently used in rats. However, these flaps are not suitable for research studies into the physiology of perforator-based flaps.<sup>4-7</sup> In addition, these models may not be as appropriate as flaps that are in the hind limbs, particularly for investigations relating to flap failure in a lower extremity involving venous insufficiency or neuropathy. Flap models based on the axial arteries of the extremities of rats will provide more information about the use of lower leg flaps in humans.

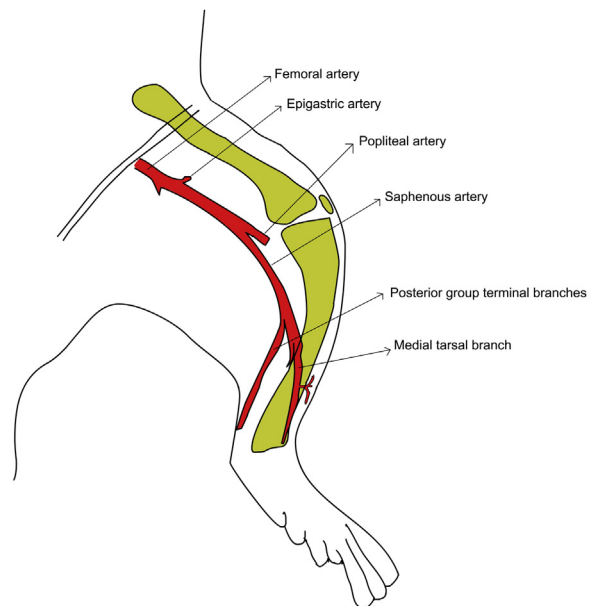
There is no standard flap design for the extremities of rats and very little research has been done on perforator flaps. In this study, the authors assessed the cutaneous perforators of the saphenous artery and its medial tarsal branch and designed new flap models. These freshly designed random and perforator-based flap models can be used for studies of lower-extremity flaps.

## Materials and method

This study was approved by the Local Animal Experiments Ethics Committee, under the protocol number 2015/05. The experiment was conducted in three stages: anatomic studies for perforator mapping, histologic analysis of flap tissues used in rats, and flap studies on the hind limbs of rats. The study included 35 female Wistar Albino rats, each weighing 180-200 g. The rats were fed nothing orally on the night before the procedure. Each rat received a mixture of intraperitoneal ketamine (50 mg/kg) and xylazine (10 mg/kg) as anesthesia. Any of the rats' hair that was in the operative field was shaved, and the skin was cleaned with antiseptic solution. The anatomic terminology used in this study is adapted from Greene's *Anatomy of the Rat*.<sup>8</sup>

### Anatomic studies for perforator mapping

The first stage of the study was to map the perforators of the saphenous arteries which is a branch of the femoral arteries in the hind limbs of the rats (Fig. 1). The hind limbs of five rats were dissected under an operating microscope. These limbs were then tied in a stretched position, and the anterior skin was dissected through a 4-cm-long incision beginning at the proximal part of the thigh region and ending at the ankle on the lateral edge of the hind limb. The rats' femoral arteries were exposed, and the dissection continued through the saphenous arteries and their medial tarsal branches up to the ankles. The septocutaneous perforators arising from the

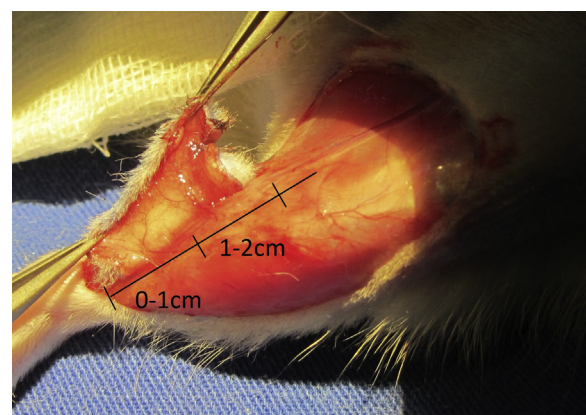


**Fig. 1 – Schematic drawing of the vascular anatomy of the hind limb of a rat. (Color version of figure is available online.)**

saphenous arteries and their medial tarsal branches from the knee-to-ankle regions were assessed. The leg regions of the rats were divided into three parts for the perforator mapping: the most distal part (1 cm from the ankle), the middle part (1.01-2 cm from the ankle), and the proximal part (2.01 cm from the ankle to the knee; Fig. 2).

### Histologic analysis of flap tissues in rats

To compare the contents and structures of different flap tissues that are commonly used in the skin of the hind limbs of rats, specimens were taken for biopsy from three sites: the anteromedial part of the hind limb, the epigastric region, and the McFarlane flap site. Biopsies were performed on the tissues of the five rats that were used in the perforator mapping. The tissue samples taken were fixated in 10% formaldehyde



**Fig. 2 – Perforator mapping of the saphenous artery and its medial tarsal branch. (Color version of figure is available online.)**

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