

A Novel Perforator Flap Training Model Using a Chicken Leg

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Abstract

Introduction Living animal models are frequently used for perforator flap dissection training, but no ex vivo models have been described. The aim of this study is to present a novel nonliving model for perforator flap training based on a constant perforator in the chicken leg.

Methods A total of 15 chicken legs were used in this study. Anatomical dissection of the perforator was performed after its identification using ink injection, and in four of these specimens a perforator-based flap was raised.

Results The anatomical dissection revealed a constant intramuscular perforator with a median length of 5.7 cm. Median proximal and distal vessel diameters were 0.93 and 0.4 mm, respectively. The median dissection time was 77.5 minutes.

Conclusion This study introduces a novel, affordable, and reproducible model for the intramuscular dissection of a perforator-based flap using an ex vivo animal model. Its consistent perforator and appropriate-sized vessels make it useful for training.

Keywords

- microsurgery
- training
- perforator flap
- chicken

Introduction

Preclinical training in perforator flap dissection has been based on living animal models; however, continuous training with these models is not always feasible due to ethical or economical reasons. The development of new alternatives for training, such as nonliving biological models may be needed.

Perforator flaps have gained popularity in the past 15 years, mainly due to their better accuracy in the reconstruction while minimizing donor-site morbidity.¹ The “Gent” consensus on perforator flap terminology² defined the perforator flap as a flap, consisting of skin and/or subcutaneous fat in which the vessels that supply blood may pass through or in between deep tissues, mainly muscle, making an intramuscular dissection frequently required.^{1,2} A highly precise microsurgical technique is needed for harvesting perforator flaps, especially during the intramuscular pedicle dissection.^{3,4} There is a steep learning curve implicit in this

technique,^{5,6} which is why preclinical training is necessary to obtain sufficient skills in harvesting perforator flaps. In vivo training models for perforator flaps have been described in rats and pigs.^{7,8} The anteromedial thigh flap and the cranial epigastric perforator flap have been described as reliable training models for perforator flap dissection using living rats, but they have the disadvantage of considerably small diameter perforators (range, 0.1–0.3 mm).^{9,10} Other perforator flaps as the deep superior epigastric artery flap, thoraco-dorsal artery perforator flap, and superior gluteal artery perforator flap have also been described in living porcine models.^{11,12} Nonliving biological models have the advantage of being more economical and accessible than living animal models, which require dedicated research protocols, approved local and international ethical standards, and specialized facilities. Following a stepwise training program starting with nonliving models reduces the number of required live animals to achieve microsurgical skills, and should be a

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previous step toward them.¹³ Chicken wings and thighs have been used as ex vivo training models for acquiring skills in microsurgical vascular anastomoses^{13–15} and have been described as a convenient and cost-effective method for continuous training.

We have identified a musculocutaneous perforator emerging from the anteromedial aspect of the chicken leg, suggesting the possibility of using this vessel for training purposes. The aim of this study is to introduce a novel perforator flap dissection model using a nonliving chicken leg.

Materials and Methods

Specimens

A total of 15 chicken legs were obtained from a local store. Each one was examined to assure that the skin was still attached to the muscle. The chicken weight, age, and size were unknown. In 10 chicken legs, an anatomical dissection was performed and in 1 specimen an angiographic study with ink injection was realized. In four chicken legs, a cutaneous flap was designed based on the perforator and intramuscular dissection was made.

Equipment

An Omano (Wirtz, Virginia, United States) trinocular boom stand microscope with $\times 10$ magnification was used. When reaching smaller vascular branches a higher magnification was used. Microsurgical instruments and 9–0 nylon sutures (Ethilon, Ethicon Inc., New Jersey, United States) were also required. Measurements of vascular branches were taken with a generic digital caliper with a 0.01 mm resolution (\blacktriangleright Fig. 1).

Dissection Technique

With the anterior face of the chicken leg oriented toward the surgeon, a midline incision over the skin between the knee and the ankle joint was made (\blacktriangleright Fig. 2). The perforator vessel was

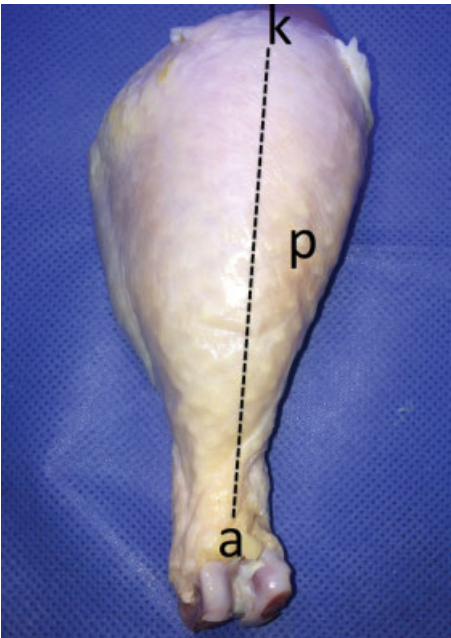


Fig. 2 Preoperative marking in the chicken leg, with its anterior face oriented toward the surgeon. k, knee; a, ankle joint; p, perforator vessel; dotted line, incision.

identified through a blunt dissection medially to the incision. Intramuscular dissection of the pedicle was performed until the proximal end of the tibia was reached (\blacktriangleright Fig. 3). In one specimen, ink was injected proximally into the artery and vein using a 24 G \times 0.75" Teflon intravenous catheter (Moore Medical LLC, Farmington, Connecticut, United States) (\blacktriangleright Fig. 4). Proximal and distal artery and vein external diameters (millimeters), number of collaterals and their diameter (millimeters), and pedicle length (centimeters) were registered. The distance of the perforator vessel from the central point of the chicken leg was also measured (centimeters).

Flap Design

The flap was designed 3 cm around the perforator vessel. The fascia was dissected and the vessel was followed through its intramuscular path. The muscle was excised and branches



Fig. 1 Instruments used during the procedure, including: microsurgical scissors, forceps and a needle-holder, a digital caliper and 9–0 nylon sutures.

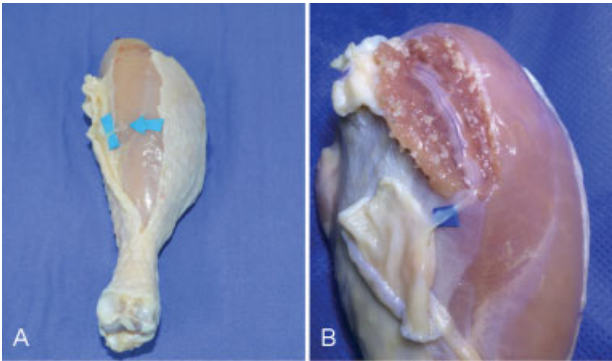


Fig. 3 Dissection of the pedicle. (A) Perforator vessel emerging from the muscle (arrow). (B) Complete intramuscular dissection of the perforator vessel.

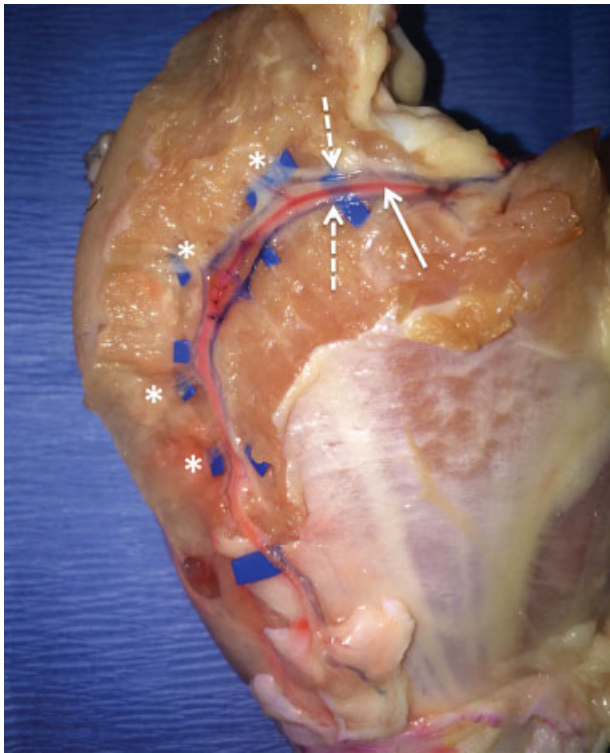


Fig. 4 Angiographic study with ink injection in which one artery (arrow), two veins (dashed arrows), and multiple collaterals (asterisk) were identified.

were ligated proximally using nylon 9-0 sutures (► **Fig. 5**). The time needed (minutes) for flap harvest was registered.

The descriptive statistics were reported as median and interquartile range (IQR) (25th and 75th percentiles)

Results

The pedicle consisted of one artery and two veins. The perforator was consistently present in all dissections and it was always inside a 3 cm diameter medially to the incision. The pedicle had a median length of 5.7 cm (IQR, 5.4–5.8 cm). The proximal artery and vein diameters were 0.94 mm (IQR,

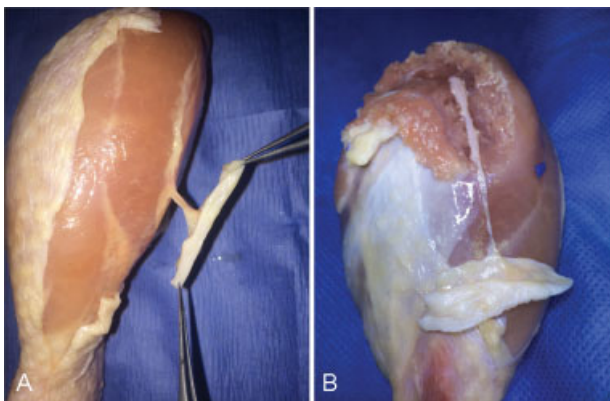


Fig. 5 Perforator flap dissection. (A) Cutaneous flap based on the perforator vessels. (B) Complete dissection of the perforator flap.

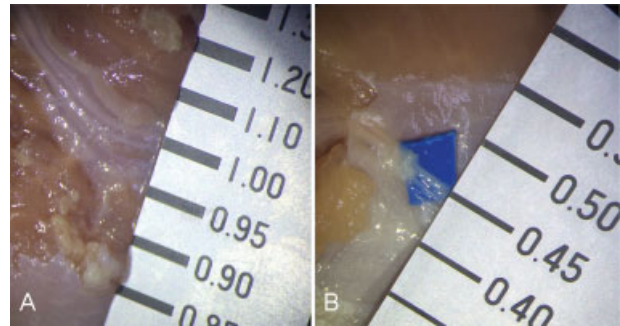


Fig. 6 (A) Proximal perforator artery and vein. (B) Distal perforator artery and vein.

0.8–1.12 mm) and 0.95 mm (IQR, 0.8–1.03 mm); the distal artery and vein external diameters were 0.43 mm (IQR, 0.36–0.43 mm) and 0.33 mm (IQR, 0.3–0.4 mm), respectively (► **Fig. 6**). Eighteen (range, 15–21) collaterals were identified. In 12%, the collaterals diameters were less than 0.3 mm, in 51% between 0.3 and 0.7 mm and in 37% greater than 0.7 mm. The median dissection time to raise the flap was 77.5 minutes (IQR, 74–90 minutes).

Discussion

The importance of training in microsurgery cannot be underestimated. Microsurgical skills are difficult to learn and demand fine motor skills and excellent eye hand coordination. These skills can only be developed through repetition, highlighting the importance of simulators when training residents, which allows them to rehearse multiple times until mastery is achieved. Dissecting a perforator requires meticulous attention to detail and in the hands of surgeons with a limited experience in the field of perforator flap surgery, this procedure may result in increased operative time.⁴ We believe that a step-wise approach using increasing complexity training models could benefit surgeons and patients as well.

The proposed model represents a simple and accurate way to train intramuscular dissection of vascular structures; skill we believe is crucial when raising perforator flaps. Swine and rat models have been described as perforator training models on living animals.^{8–12,16} The advantages of using nonliving chicken models relies on having low cost and readily available simulation models for continuous training in the laboratory without ethical or major logistic issues.¹³ Even though the chicken muscle is slightly less fibrous than the human muscle, our impression is that it achieves to replicate the feeling of dissecting the intramuscular perforator. The dissection time seems adequate in terms of the length of the pedicle, the size of the vessels and the numerous collaterals. The diameter of the vessels in the distal portion of the pedicle is bigger than those described in rat models, which makes this model suitable for practicing before using the living animal model. Also, this model replicates the diameters needed for using perforators as recipient vessels.^{17,18} In contrast to the living animal models; our model cannot replicate thrombosis and bleeding, even though a pump machine can be connected to the proximal end of the vessel simulating pulse.^{19,20}

Valid and objective assessment methods for evaluating skill acquisition in this model are still to be made, ultimately allowing its validation and demonstration of skill transfer to the operating room.

Conclusion

To our knowledge, this is the first description of a nonliving biological simulation model for training in the intramuscular dissection of perforator flaps. As many nonliving models, it is economical and easily obtainable, making continuous training readily accessible.

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