OPEN
PRS GLOBAL OPEN
IDEAS AND INNOVATIONS
Education

Training in Vascular Microsurgery: The Ex Vivo Biological Model on Domestic Turkey Leg (*Meleagris gallopavo*)

Francesca La Torre, MD*
Vincenzo Manfellotto, MD†
Vincenzo Mazzarella, MD†
Luigi Sorbino, MD‡
Matteo D'Alessio, MD†
Carlo Petroccione, MD*
Maria Maddalena Nicoletti, MD†
Giuseppe Andrea Ferraro, PhD, MD†
Gorizio Pieretti, PhD, MD†

Summary: There are various models for practicing microsurgical anastomoses, from synthetic to ex vivo and in vivo biological ones. In this study, we present the domestic turkey (*Meleagris gallopavo*) as an ex vivo biological model in the practice of surgical anastomoses. In our opinion, it represents a model that is very similar to a human one, low cost, and easy to find. In fact, our study shows that the diameters of the arteries and veins used for anastomoses (tibial artery diameter: 2.5 ± 0.6 mm; tibial vein diameter: 3.5 ± 1.2 mm) are similar to those of human arteries and veins most frequently used in microsurgical free flaps. So, we believe that this animal model is a great model for microsurgical training for doctors who approach this difficult and long to learn discipline. *(Plast Reconstr Surg Glob Open 2024; 12:e5733; doi: 10.1097/GOX.0000000000005733; Published online 10 April 2024.)*

INTRODUCTION

Microsurgical training has always been an arduous and very long path for doctors who approach this discipline, especially in researching of vessels and practicing the microsurgical anastomoses. However, this discipline plays a fundamental role in plastic surgery. For this reason, we have always looked for a training model that is similar to human to be able to exercise in the best way. At the beginning, the models used for training were represented by synthetic models that were easy to find and low cost (such as silicone tubes or noodles),[1] and then moved on to ex vivo biological models (such as the chicken leg[2] or the kidneys[3] and the spleen of the pig)[4] that are more similar to the human model. This progression results in a more stimulating environment and adds greater fidelity to the reality for vascular anastomosis simulations. In this article, we present a new ex vivo biological model for the development of basic and advanced microsurgical skills represented by the domestic turkey leg (*Meleagris gallopavo*). The use of the domestic turkey wing has already been described.[5] According to our experience, the turkey leg as a microsurgical training model includes all the features of an ideal ex-vivo biological model: it is easily affordable and economically sustainable, allows faithful reproduction in both the research phase of blood vessels and the vascular anastomosis phase, and does not have vascular anatomical variability, thus providing a valid experience for the development of microsurgical skills.

*From *Burn and Plastic, Reconstructive Unit, "A. Cardarelli" Hospital, Napoli, Italy; †Plastic, Reconstructive and Aesthetic Surgery Unit, Campania University "L. Vanvitelli," Napoli, Italy; and ‡Plastic, Reconstructive and Aesthetic Surgery Unit, Napoli University "Federico II," Napoli, Italy.*

Received for publication October 7, 2023; accepted February 20, 2024.

DOI: 10.1097/GOX.0000000000005733

MATHERIAL AND METHODS

Turkey legs were purchased from a legal butchery slaughterhouse. First, anatomical pieces of the turkey leg were washed with water to remove blood and clots. Dissection was then performed along the gastrocnemius and peroneal muscles to identify the popliteal vessels. The tibial vein and artery were isolated between the septa of the flexor and extensor muscles and were exposed along their entire length. The two vessels were transversely dissected and prepared for microsurgical training. Specific materials, tools, and an optical microscope were used to perform the vascular anastomoses (Fig. 1). Thirty end-to-end anastomoses were performed using 9/0 Prolene (polypropylene; Ethicon). During the procedures, we evaluated the vessels diameters, execution time of the anastomoses, and vessel patency. The patency test was performed with the use of povidone iodine instead of the more common dye; in that way, we were able to wash and reuse the vessel for additional sutures.

Disclosure statements are at the end of this article, following the correspondence information.

RESULTS

No significant anatomical variations were observed among the used animal models. The mean vessel length of the anatomical models was 20.50 ± 4.55 cm. The average time to perform arterial anastomosis was 21.52 ± 3.55 minutes. The mean diameter of the isolated arterial vessels was 2.5 ± 0.6 mm. Regarding venous anastomosis, the average duration of the procedure was 21.17 ± 4.10 minutes, and the average diameter of the isolated venous vessels was 3.5 ± 1.2 mm. The anastomosis patency test performed in all the cases yielded positive results. All data were collected in Table 1.

DISCUSSION

A year of training was needed to achieve successful results. It is obvious that a strict training program for young microsurgeons is important to achieve the desirable outcome. Training guarantees the microsurgeon the acquisition of theoretical notions and basic skills to quickly and effectively complete vascular anastomoses. To reach this level of ability, beginner microsurgeons will initially approach various types of models. At the beginning, they use synthetic or nonbiological models, such as the silicone tubes of angiocaths, flower petals,[6] or noodles.[1] Once the microsurgeons are used to the caliber of the wires, the instruments, and the microscope, they will be able to switch to the use of ex vivo models that more faithfully simulate human anatomy. Different animal models are used for this purpose: the spleen[4] and kidneys of pigs,[3] turkey wings,[5] or even chicken legs.[2] Instead, we aimed to standardize the use of the turkey leg as a biological model for microsurgical training. The turkey leg has the characteristics of an ideal model: it is easy to buy and is low cost; it can be easily stored in the fridge for 2–3 days. Compared with the chicken leg,[2] it has some advantages: the dissection of the turkey leg is simplified because the vessels are larger, thickness of the tunica adventitia and media are greater, and the diameters of the anterior tibial vessels are greater than those of the chicken (chicken tibial vessel diameter 1.18 ± 0.19 mm).[2] In addition, the turkey leg is cheap; the cost is about $5.50, equal or similar to the chicken leg. Furthermore, there are advantages over pig models, which are affected by the difficulty of availability and do not faithfully represent reality because the vessels are separated, there are no nerve components, and the muscular layer is absent.[7] Regarding the turkey leg model, we noticed that the tibial artery diameter is very similar to one of the main arterial pedicles used in plastic surgery. In fact, the radial artery diameter used to harvest the radial forearm free flap is approximately 2.3 mm, the diameter of the deep inferior epigastric artery to harvest the transverse rectus abdominal myocutaneous flap is 2.9 mm,[8] the diameter for the thoracodorsal artery in the latissimus dorsi myocutaneous flap is 2.8 mm,[9] and 3.16 mm is the diameter for the descending branch of the lateral femoral circumflex artery in the anterolateral thigh myocutaneous flap.[10] Consequently, the tibial artery of the turkey leg is a better approximation of the size of common human reconstructive microsurgical procedures than other common models. Particular attention should be paid to our technique for the patency test: the use of an iodopovidone solution allows for visualization of the vessel and washout with some water. Thus, without the use of dyes, it is possible to reuse the model and revive the same experience as the first time it was used.

Takeaways

Question: We aimed to use a new model for microsurgery training.

Findings: In this study, we present the domestic turkey (*Meleagris gallopavo*) as an ex vivo biological model in the practice of surgical anastomoses. In our opinion, it represents a model that is very similar to a human one, low cost, and easy to find. In fact, our study shows that the diameter of the arteries and veins used for anastomoses is similar to that of human arteries and veins most frequently used in microsurgical free flaps.

Meaning: Training in microsurgery with a biological model that is economic, reproducible, and similar to the human one.

CONCLUSIONS

The biological model based on the domestic turkey provides an alternative method that is not inferior to other models already described because it is economically sustainable (price around $5.50) and easily reproducible for training in microsurgery, offering constant anatomy in all the pieces used and a faithful microsurgical experience. Furthermore, any nonliving animal model is inferior to a living model, also with a greater cost (silicone tubing costs >$70). In addition, with this biological model, it is possible to have a unique, economical, and reproducible method based on the high conformity of anatomical structures of greater caliber compared with other ex vivo animal models, capable of making the approach simple even for less experienced microsurgeons. Furthermore, the turkey thigh musculature is very well represented, with thicker muscle fibers, allowing us a simpler dissection with a lower risk of vessel injury and the possibility of the isolation of perforating vessels during the dissection, constituting a source of practical experience on microsurgical flaps based on these vessels.

Vincenzo Mazzarella, MD
Piazza Miraglia 2
Napoli, Italy
E-mail: vinc.mazzarella@gmail.com

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

ACKNOWLEDGMENT

All procedures in this study involving human participants were performed in accordance with the ethical standards of the

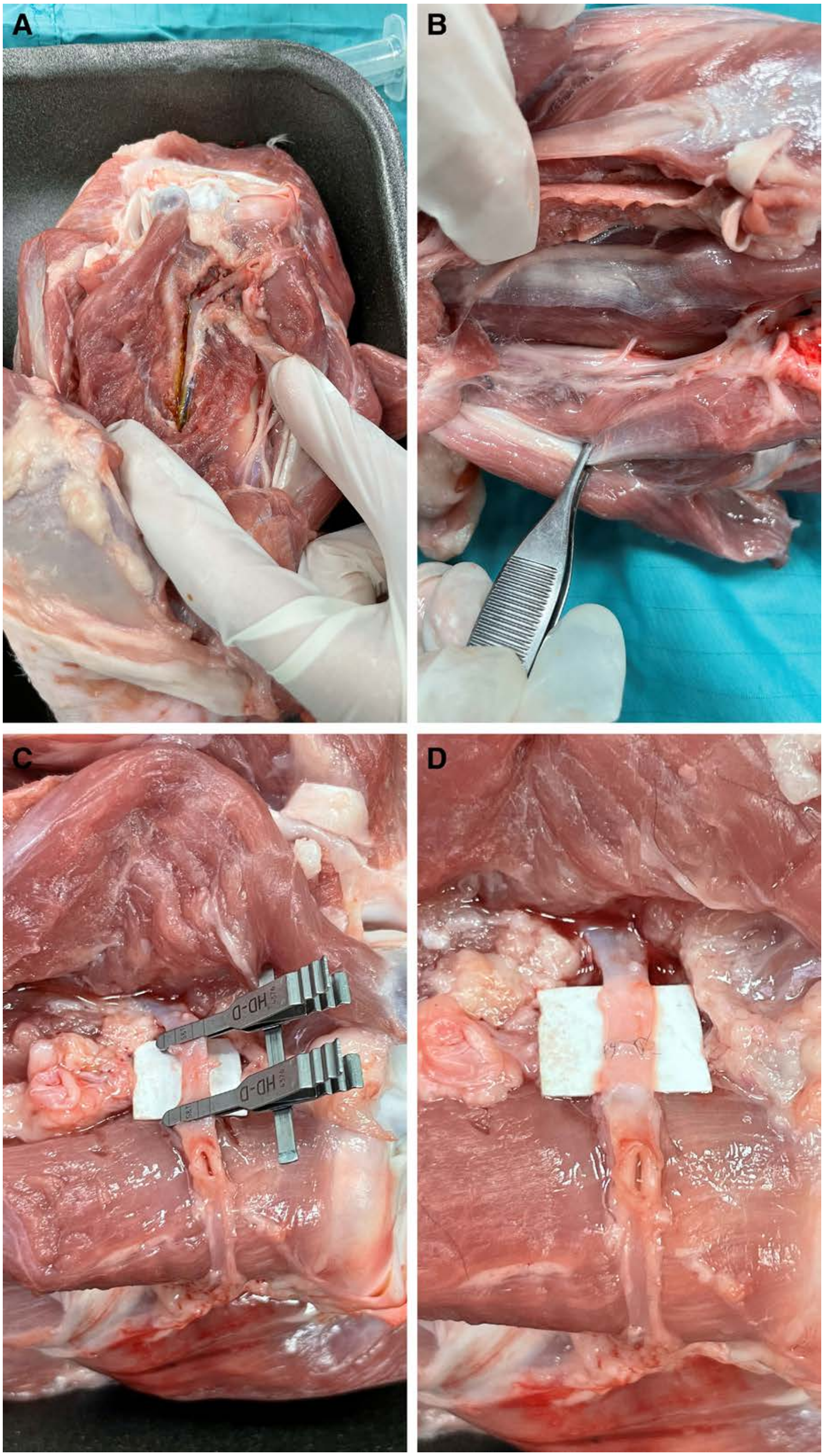

Fig. 1. Anatomical dissection of a turkey leg. A, Vessel identification. B, Dissection. C, Preparation of the vessel for anastomosis. D, Vascular anastomosis.

Table 1. Collected Data

	Tibial Artery	Tibial Vein
Vessel length (mean ± SD)	20.50 ± 4.55 cm	20.50 ± 4.55 cm
Vessel diameter (mean ± SD)	2.5 ± 0.6 mm	3.5 ± 1.2 mm
Performing time (mean ± SD)	21.52 ± 3.55 min	21.17 ± 4.10 min

institutional and/or national research committee and the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

REFERENCES

1. Shimizu T, Yoshida A, Omokawa S, et al. A microsurgery training model using konjac flour noodles. *Microsurgery*. 2019;39:775–776.
2. Kang BY, Jeon BJ, Lee KT, et al. Comprehensive analysis of chicken vessels as microvascular anastomosis training model. *Arch Plast Surg*. 2017;44:12–18.
3. Dos Reis JMC, Teixeira RKC, Santos DRD, et al. Novel porcine kidney-based microsurgery training model for developing basic to advanced microsurgical skills. *J Reconstr Microsurg*. 2021;37:119–123.
4. Maluf JV, Duarte Da Silva AB, Growth AK, et al. An alternative experimental model for training in microsurgery. *Rev Col Bras Cir*. 2014;41:072–074.
5. Bates B, Wimalawansa SM, Benjamin Monson B, et al. A simple cost-effective method of microsurgical simulation training: the turkey wing mode. *J Reconstr Microsurg*. 2013;29:615–618.
6. Volovici V, Dammers R, Lawton MT, et al. The flower petal training system in microsurgery validation of a training model using a randomized controlled trial. *Ann Plast Surg*. 2019;83:697–701.
7. Cooper L, Sindali K, Srinivasan K, et al. Developing a three-layered synthetic microsurgical simulation vessel. *J Reconstr Microsurg*. 2019;35:15–21.
8. Colohan S, Maia M, Langevin CJ, et al. The short- and ultrashort-pedicle deep inferior epigastric artery perforator flap in breast reconstruction. *Plast Reconstr Surg*. 2012;129:331–340.
9. Thomas BP, Geddes CR, Tang M, et al. The vascular basis of the thoracodorsal artery perforator flap. *Plast Reconstr Surg*. 2005;116:818–822.
10. Feng Y, Li WT, Wang NL, et al. Anatomic study of anterolateral thigh perforators flap and its clinical significance in reconstruction of head and neck defects. *Zhongguo Yi Xue Ke Xue Yuan Xue Bao*. 2010;32:81–84.