Use of Chicken Thigh Vessels as a Model for Microsurgical Vessel Coupling

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Использование сосудов бедра цыпленка в качестве тренировочной модели для выполнения микрохирургического соединения

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使用鸡腿血管作为显微外科血管连接的模型

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Introduction: Since the 1970's microvascular free tissue transfer has become an important part of head and neck reconstruction training. Arguably, one of the biggest advantages since then, has been the introduction of the vessel coupler which provides intima to intima closure and significantly decreases the time needed to perform an anastomosis. Traditionally, live animal models have been used for training, however given the cost and ethics regarding such models, others have been investigated for microsurgical suturing. Unfortunately, most of these models lack the physical properties needed to practice coupling techniques and none have been investigated for this purpose.

Methods: Participants from the microvascular training course held by a microvascular Head and Neck team in Omaha, NE dissected chicken thigh vessels, measured vessel diameter, and performed successful coupling using standard microvascular techniques. Items measured included total time to dissect and expose chicken thigh vessels, coupler size used for anastomosis, total time required to perform the anastomosis and vessel patency after anastomosis measured with intraluminal dye injection.

Results: The average time to expose the neurovascular bundle was 4.47 (+/- 3.40) minutes and average time to perform the coupling procedure was 6.70 (+/- 2.29) minutes for all participants. Average coupler size used was 2.18 (+/-0.42) mm and no vessel used was smaller than 1.5mm. All vessels that were coupled by study participants were successfully patent.

Conclusion: The chicken thigh model provides consistent caliber vessels well suited for microvascular training. This model is cheap, accessible and works well for novice and experienced health professionals and trainees.

Involvement: All authors were involved in acquisition of data as well as creation and review of the document.
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The authors are responsible for the originality of the data presented and the possibility of publishing illustrative material – tables, figures, photographs of patients.

Актуальность. С 1970-х гг. свободная пересадка ткани с применением микрососудистой техники стала важной частью обучения реконструкции тканей головы и шеи. Возможно, одним из самых больших достижений с тех пор было введение в практику устройства для соединения сосудов, которое обеспечивает сопоставление интимы и значительно сокращает время, необходимое для наложения анастомоза. Традиционно для обучения использовались модели живых животных, однако, учитывая стоимость и этичность применения таких моделей, различные авторы исследовали другие модели для микрохирургического наложения швов. К сожалению, большинство моделей не обладает физическими свойствами, необходимыми для отработки техник соединения, и ни одна из них не исследовалась для этих целей.

Методы. Участники учебного курса по микрососудистой хирургии, проведенного группой специалистов по микрохирургии головы и шеи в Омахе, Северо-Восточная Каролина, препарировали сосуды бедра цыпленка, измерили диаметр сосудов и успешно наложили соединение, используя стандартные микрососудистые техники. Измеряемые параметры включали общее время, необходимое для выделения и обнажения сосудов куриного бедра, размер муфты, используемой для анастомоза, общее время, необходимое для выполнения анастомоза, и проходимость сосуда после анастомоза, измеренную с помощью внутрипросветного введения красителя.
Результаты. Среднее время обнажения сосудисто-нервного пучка составило 4,47 (+/- 3,40) минуты, а среднее время выполнения процедуры соединения составило 6,70 (+/-2,29) минуты среди всех участников. Средний размер используемой муфты составлял 2,18 (+/-0,42) мм, и ни один из используемых сосудов не был меньше 1,5 мм. Все сосуды, соединенные участниками исследования, были проходимы.
Вывод. Модель куриного бедра имеет сосуды постоянного калибра, хорошо подходящие для тренировки микрохирургических техник. Данная модель дешева, доступна и подходит как для начинающих, так и для опытных медицинских работников и стажеров.

Конфликт интересов. Авторы заявляют об отсутствии конфликта интересов.
Финансирование. Финансирование исследования проводилось из собственных средств авторов.
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Авторы несут ответственность за оригинальность представленных данных и возможность публикации иллюстративного материала – таблиц, рисунков, фотографий пациентов.

介绍：自20世纪70年代以来，微血管自由组织移植已成为头颈部重建训练的重要组成部分。自20世纪70年代以来，微血管自由组织转移已成为头颈部重建训练的一个重要部分。可以说，从那时起，最大的优势之一是引入了血管耦合器，它提供了内膜到内膜的闭合，大大减少了进行吻合的时间。传统上，活体动物模型被用于训练，然而鉴于这种模型的成本和伦理问题，其他的模型已经被研究用于显微外科缝合。不幸的是，这些模型中的大多数缺乏练习耦合技术所需的物理特性，而且没有一个模型被研究用于这一目的。

方法：来自东北奥马哈的微血管头颈部团队举办的微血管培训课程的学员解剖了鸡大腿血管，测量了血管直径，并使用标准的微血管技术成功进行了连接。测量的项目包括解剖和暴露鸡大腿血管的总时间、用于吻合的耦合器大小、进行吻合所需的总时间以及用管内染料注射测量吻合后的血管通畅性。

结果：所有参与者暴露神经血管束的平均时间为4.47（+/−3.40）分钟，进行连接手术的平均时间为6.70（+/−2.29）分钟。平均使用的耦合器尺寸为2.18（+/−0.42）毫米，没有使用的血管小于1.5毫米。所有参与研究的人所连接的血管都成功获得了专利。

结论：鸡大腿模型提供了口径一致的血管，非常适合微血管训练。这个模型很便宜，容易获得，对新手和有经验的卫生专业人员和受训者都很有效。

参与情况：所有作者都参与了数据的获取以及文件的创建和审查。

披露：作者没有什么可披露的。

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Introduction

Since the 1970's, microvascular free tissue transfer has become an irreplaceable reconstructive technique for optimal treatment of many head and neck patients. As a result, trainees are required to learn a new skill-set of microvascular surgery. The introduction of the vessel coupler which provides direct intima to intima closure without introduction of intraluminal foreign body material is arguably one of the biggest technological advances in microvascular tissue transfer since its inception. As important, vessel coupling decreases the time needed to perform an anastomosis. Several training models have been described to improve microvascular suturing techniques but none of the synthetic or biosynthetic models have possessed adequate physical properties needed to practice vessel coupling in addition to some being very expensive [1]. Traditionally live animal models have been used to train vessel coupling, however, ethics

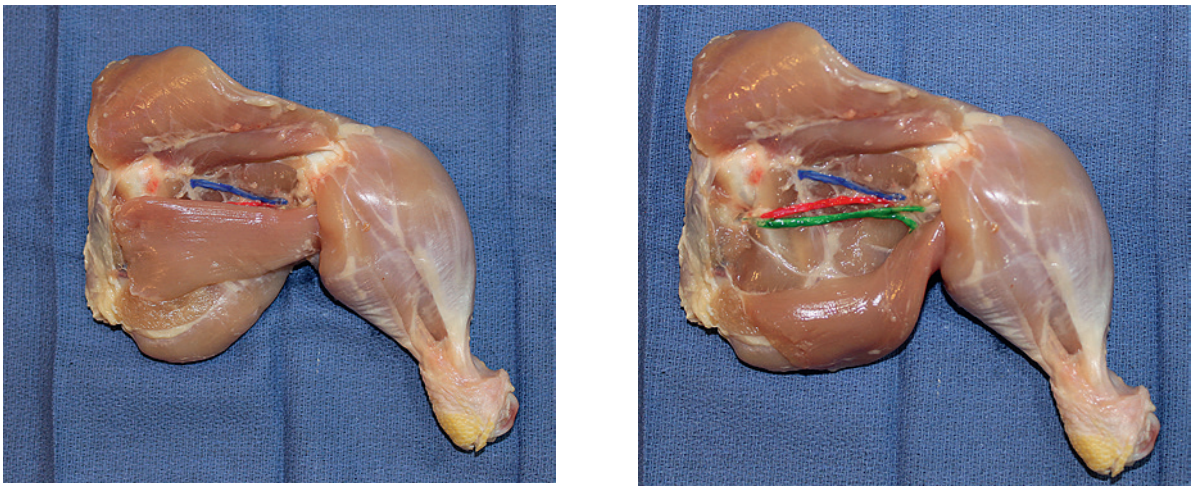

Figure 1. Dissected chicken thigh.
Legend: (a) Iliotibial muscle reflected to show femoral vein (blue) and (b) Iliofibularis muscle reflected to expose the entire neurovascular bundle: ischiatic artery (red), femoral vein (blue), and ischiatic nerve (green).
Рис. 1. Куриное бедро после диссекции.
Условные обозначения: (а) Подвздошно-большеберцовая мышца сдвинута для демонстрации бедренной вены (синяя), (б) подвздошно-малоберцовая мышца сдвинута для демонстрации всего сосудисто-нервного пучка: седалищная артерия (красный), бедренная вена (синий) и седалищный нерв (зеленый)

of performing terminal procedures on animals for practice and the associated costs have been prohibitive in making such models wide-spread and accessible [2]. With the increased emphasis on clinical competence and the decrease number of allowable workable hours available to trainees, better models are necessary to ensure adequate training.

The fresh chicken thigh, obtained from your local grocer at a low price, has been described as an excellent model for microneurovascular suturing given its similar sized vessels to many free flaps used in the head and neck [3]. Its application in teaching venous and arterial coupling skills has not been described or validated. This manuscript describes successful use of the chicken thigh model in coupling techniques using the ischiatic artery and femoral vein for reconstruction training.

Methods

Participants from the Microvascular Training Course were asked to volunteer to participate in this observational study. Participants ranged in their level of training from PGY-2 to PGY-8 and also included physician assistants and staff physicians. Each subject received a group lecture regarding dissection of the chicken thigh to expose the neurovascular bundle as well as a lecture on microvascular suture and coupling techniques.

The participants were then given a fresh undissected chicken thigh and were asked to record the time required to adequately expose the chicken vessels. Dissection included removal of all chicken skin followed by reflection of the iliotibial muscle superiorly to expose the iliofibularis muscle and femoral vein (Figures 1a). Next the iliofibularis muscle was dissected and reflected inferiorly to expose the remainder of the neurovascular bundle including the ischiatic artery and nerve (figure 1b).

Once the vessels were exposed the participant was asked to identify the vessel of choice (artery or vein), divide the vessel and measure the lumen size with the coupler measuring device (Figure 2). Finally, coupler anastomosis was performed using the Synovis Microvascular Coupling Device (Birmingham, AL, USA) (Figure 3). Measuring of vessel diameter and vessel anastomosis was performed using wall mounted microscopes and standard microvascular instruments. After vessel anastomosis was complete a 24 gauge needle was inserted into the lumen of the vessel and red dyed water was infused to ensure patency of the vessel and the lack of anastamotic dehiscence. Lumen size, time to complete the anastomosis and vessel patency were all obtained for each chicken thigh used.

Results

Twenty-nine chicken thighs were evaluated for inclusion in this study. Trainees ranged from PGY2 level to PGY 8 level and included

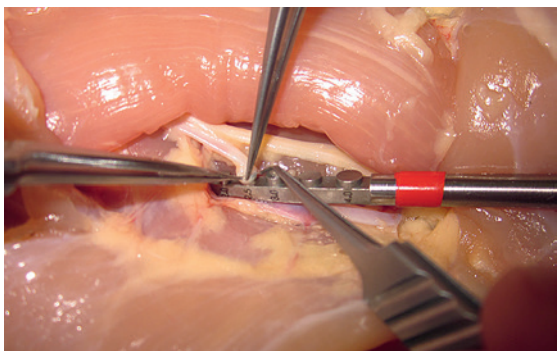

Figure 2. Microsurgical measurement of thigh vessels.
Legend: Vessel coupler measuring device being used to accurately determine the correct size of coupler to be used at 2.5mm.
Рис. 2. Микрохирургическое измерение сосудов бедра.
Условные обозначения: Измерительное устройство соединителя сосуда используется для точного определения правильного размера соединителя, который следует использовать при диаметре 2,5 мм.

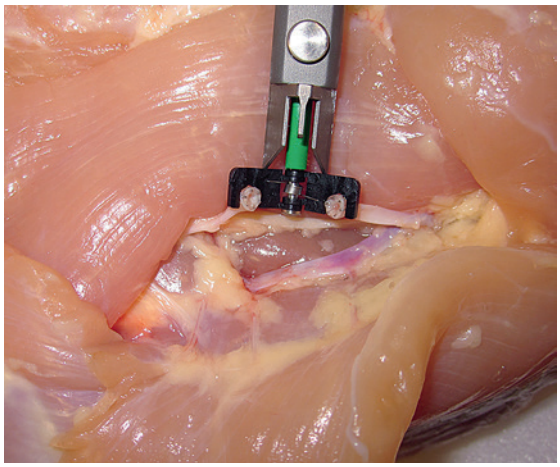

Figure 3. Anastamosis of ischiatic artery.
Legend: 2.5mm coupler device used to anastamose the ischiatic artery.
Рис. 3. Анастомоз седалищной артерии.
Условные обозначения: соединительное устройство диаметром 2,5 мм, используемое для наложения анастомоза седалищной артерии.

several Otolaryngology PA's and Staff Surgeons. The average time to expose the neurovascular bundle was 3.31 (SD = +/-2.45) minutes and average time to perform the coupling procedure was 6.27 (SD = +/-2.15) minutes for all participants. Average coupler size used was 2.13 (SD = +/-0.32) mm and no vessel used was smaller than 1.5mm. There were no unsuccessful attempts at coupling and all vessels that were coupled by study participants were successfully patent as evaluated with red dye injection.

Discussion

Microsurgical techniques required for microvascular free tissue transfer is an essential skill for treatment of advanced head and neck cancers. Traditionally the Halstedian apprenticeship model of see, learn, do and graded responsibility have ruled the academic arena with little regard for objective evidence of competency [4]. It has long been suspected that in-training exam scores do not correlate with surgical skill. Furthermore, evidence suggests that surgical skill is superior in those trainees who practice their skills using in vitro methods compared to those with only lecture based training [4–5]. Microsurgical training courses have been shown to significantly improve microvascular global rating scores in up to 60% of trainees [6] and objective scoring systems have been validated to measure skill for microvascular surgical techniques [7]. As we enter the age of trainee work hour restrictions, increasing pressure to improve operative efficiency and the push for surgical skills training prior to real life opportunities; models that bridge the gap between simulation and real life will become increasingly important [8].

Multiple models exist for training purposes including living and non-living materials each with their own strengths and weaknesses [1]. Bench models like silastic or silicone tubing, surgical gauze and latex gloves are all cheap, portable and often times re-usable but they can only be used to teach basic techniques and they are less lifelike making the transition to the operating room more difficult. Cadavers, live animals, and computer simulators all provide more real life situations however they are much more expensive and require more supervision and coordination in order for trainees to use these as practice models. Polyurethane synthetic vessels have been described as intermediate options that can be designed with thin or thick vessel walls and varying diameters, however this model does not completely bridge the gap between bench and patient [9]. Furthermore, there is good evidence that low fidelity bench models perform just as well as high fidelity equivalents as far as in vitro surgical skills are concerned [10–11]. This suggests that using expensive models or models with ethical implications, may be unnecessary prior to transitioning to a live in vivo experience.

Chicken and turkey products found in your local grocery store or local farms, however, have been described to bridge that gap. These products are inexpensive and do not require institutional approval for use. Some have argued that use of this model could potentially decrease the volume of live animals used by up to 80-100% [2]. The chicken leg was first described by Sucur et al. for microvascular training in 1981 [12]. The chicken thigh model offers consistency in vessel size, similar to other flaps used in the head and neck, including the anterolateral thigh, radial forearm, and fibular free flaps free flap [3, 13]. Neurosurgical literature has supported the turkey and chicken wing for microsurgical suturing techniques however the vessel sizes of 1.47 +/- 0.14 mm versus 1.07 +/- 0.25 mm respectively are generally smaller than those used in the head and neck [14–16].

Although microsurgical suturing skills are important for improvement of hand eye skills under the microscope, it is rare for residents to participate in this portion of the procedure in live patients. Microvascular coupling, however, is a skill which residents routinely participate in and no model has ever been described or validated for teaching this skill. In our description we clearly show that this skill can be easily taught to trainees of all experience and

Table 1. Presents average times for vessel exposure and coupling as well as average coupler size used for the chicken thigh vessels
Таблица 1. Представлено среднее время экспозиции сосудов и наложения соединения, а также средний размер соединения, используемого для сосудов бедра цыпленка

	Average *Среднее*	**Std. Deviation** *Стд. отклонение*
Vessel Exposure Time (min) *Время экспозиции сосуда (мин)*	4.47	+/- 3.40
Coupler Anastamosis Time (min) *Время наложения муфты (мин)*	6.70	+/- 2.29
Coupler Size (mm) *Размер муфты (мм)*	2.18	+/- 0.42

*No vessel was smaller than 1.5mm.
*All anastomosis attempts were successful.
** Ни один сосуд не был меньше 1,5 мм.*
**Все попытки наложения анастомоза были успешными.*

skill levels with great success. The chicken thigh model provides vessels similar in size to those generally found in the head and neck, the tissue is equivalent to that of human tissue and thus it fulfills the lab to life gap required in the academic training arena.

Conclusion

The chicken thigh training model provides consistent caliber vessels and is well suited for training microvascular coupling and suturing techniques. It provides the added benefit of long vessels allowing for several anastomoses within the same specimen. This model is inexpensive, accessible and effective for teaching microvascular coupling techniques for all levels of training. As objective documentation of surgical competency becomes a more important, microvascular training with models similar to this will become paramount.

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