

Organic bench model to complement the teaching and learning on basic surgical skills¹

Modelo de bancada orgânico para complementar o ensino-aprendizagem de habilidades cirúrgicas básicas

Rafael Denadai^I, Luís Ricardo Martinhão Souto^{II}

^IGraduate student, School of Medical Sciences, UNIMAR, Marília-SP, Brazil. Conception, design, intellectual and scientific content of the study; involved in technical procedures; collection of study informations and manuscript writing.

^{II}PhD, Assistant Professor, Division of Plastic Surgery, Department of Surgery, School of Medical Sciences, UNIMAR, Marília-SP, Brazil. Supervised all phases of the study; conception, design, intellectual and scientific content of the study; involved in technical procedures; manuscript writing and critical revision.

ABSTRACT

PURPOSE: To propose an organic bench model made with fruits/vegetables as an alternative to complement the arsenal of simulators used in the teaching and learning of basic surgical skills during medical graduation and education.

METHODS: They were described the training strategies, through the use of fruits (or vegetables) to the learning of different techniques of incision, sutures, biopsies and basic principles of reconstruction. The preparation of bench model, the processes of skill acquisition, feedback and evaluation were also delineated.

RESULTS: A proposal for teaching based on an organic model with training delivered in multiple sessions, with increasing levels of difficulty, and with feedback and evaluation during all the process was structured.

CONCLUSION: The organic model, being simple, versatile, portable, reproducible, readily available, and having low cost, is another option to complement the existing simulators for teaching and learning of basic surgical skills.

Key words: Surgery. Education. Teaching Materials. Models, Educational. Learning. Training.

RESUMO

OBJETIVO: Propor um modelo de bancada orgânico, confeccionado com legumes/frutas, como alternativa para complementar o arsenal de simuladores aplicados no ensino-aprendizagem das competências cirúrgicas básicas durante a graduação e o ensino médico.

MÉTODOS: Foram descritas as estratégias de treinamento, através da utilização de frutas (ou legumes), para a aprendizagem de diferentes técnicas de incisão, suturas, biópsias e princípios básicos de reconstrução. A preparação do modelo de bancada, os processos de aquisição de habilidades e *feedback* e os métodos de avaliação também foram delineados.

RESULTADOS: Estruturou-se uma proposta de ensino baseada em um modelo orgânico com o treinamento distribuído em várias sessões, com níveis crescentes de dificuldade e com *feedback* e avaliação de todo o processo.

CONCLUSÃO: O modelo orgânico, por ser simples, versátil, portátil, reprodutível, disponível, de fácil aquisição e baixo custo é mais uma opção para complementar o arsenal de simuladores de ensino e aprendizagem existentes.

Descritores: Cirurgia. Educação. Materiais de Ensino. Modelos Educacionais. Aprendizagem. Capacitação.

Introduction

Based on the assumption that general practitioners are routinely faced with situations that require implementation of ambulatory surgical procedures^{1,2}, and that most physicians do not get satisfactory surgical skills during their academic training³, it is necessary to establish a training program aimed at the teaching and improving of these technical skills to undergraduates and newly graduates^{1,2}. Although different simulators have been described to provide this training⁴, none of them is complete.

In an attempt to find a simulator that presents minimum requirements for storage and that can be easily discarded, one that is simple, versatile, portable, reproducible, affordable, easy to acquire, with a low financial cost, and that permits the evaluation of practice with feedback for improving the skills/surgical technique, this study proposes the use of an organic bench model made with vegetables/fruits for teaching-learning during medical school, as a complementary alternative to the existing bench simulators.

Teaching-learning with the organic bench model for the training of basic surgical skills

The organic model can be used for training medical students who never had contact with basic surgical skills and for those who had some contact with these skills but need to improve the learned technique.

The purpose of this model is based on the teaching during several training sessions (days or weeks), interspersed with periods of rest, which can be adapted and distributed in a way that complements the curriculum already established and that can be applied in the context of the disciplines of operative technique, clinical surgery, plastic surgery, and others.

In classrooms, a group of four students should train under the direct supervision of an instructor (according to previously described by Dubrowski and MacRae⁵) and they should be encouraged to practice and refine skills at home, later bringing the model with the performed procedures for evaluation with feedback. Instructors can be faculty physicians or nonphysicians, such as laboratory technicians, surgical technicians or students who can master the technique (monitoring format); these nonphysician surgical skills coaches should be trained by a faculty surgeon to administer teaching and practice sessions.

It is important to set teaching goals in an increasing order of difficulty, which must be distributed at the sessions. The basic structure of each session is a brief talk with pictures and videos-classes on the proposals of the day, followed by training. Additional explanations can be made during practice. Initially, the

procedures can be demonstrated by the instructors to the student group. After that, specific points of the techniques can be addressed individually.

Training should be directed to the student. In the beginning of the process, the goals can be similar for all group members. However, in subsequent sessions, the proposals can vary according to the differences in the acquirement of students' abilities. As the student acquires simpler skills, the degree of difficulty should be increased.

The basic objectives proposed and described in this study include handling of surgical instruments, training of suture techniques, incisions, surgical resection with or without safety margins and incisional/excisional biopsies, and basic principles of reconstruction, such as "grafts".

Making an organic bench model

To make the model, it is only needed to have the chosen fruit (or vegetable), a plate of Styrofoam, needles (size and quantity vary according to fruit or vegetable) and a ballpoint pen or marker. For the chosen fruit (or vegetable) not slip during training, it should be fixed in the Styrofoam with needles. It is also needed No. 15 blade and No. 3 scalpel cable, anatomic and tooth rat tweezers, Mayo scissors, needled threads and Mayo-Hegar needle holder (Figure 1).

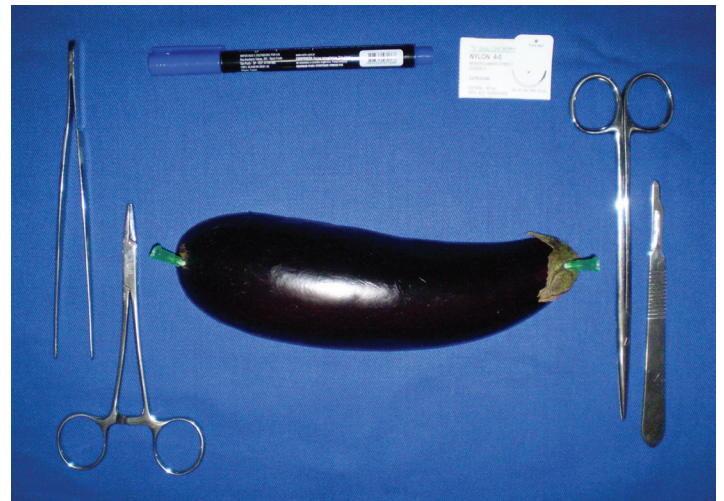


FIGURE 1 – Organic bench model and materials required for the teaching and learning on basic surgical skills.

The fruits (or vegetables) are acquired in commercial establishments, and preference should be given to those which have thicker peels and are not softened. The choice of a specific fruit or vegetable is variable. For training of sutures it is preferable to use orange, lemon or eggplant. Lemon presents the risk of staining the skin if there is exposure to sunlight after contact. On

the acquirement of skills such as removal of debris in spindles and “skin” biopsies, it is preferable to use banana, lemon or orange. Differences in costs and seasonal availability of products may also affect the choice.

Training incisions and sutures

Incisions and sutures can be trained concurrently. For this, students make a mark on the peel of the fruit or vegetable, and then make the incision in the previous mark, simulating an injury and using the taught technique. Then, sutures are made to close the edges of the incised area, also applying the teachings about the technique. Different incisions (linear, circular, vertical and horizontal) and sutures (single interrupted sutures, vertical mattress suture according to Donati and McMillen, modified vertical mattress suture according to Allgöwer, horizontal mattress suture, running simple suture and running locked suture) (Figure 2) can be trained.

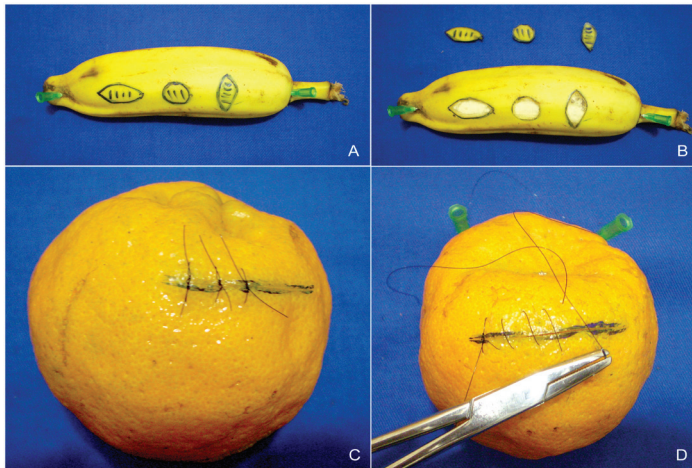


FIGURE 2 – Organic model for the learning on different techniques of incisions and sutures. (A-B) Elliptic and circular pattern. (C) Single interrupted suture and (D) running simple suture. Besides the correct way to handle instruments (scalpel, tweezers and needle) are important to teaching about the placement of the scalpel in relation to “skin” (relationship of the angles), the proper way to perform the incision (e.g., no movements of “aliasing” and no movement sideways), and carrying out the sutures (e.g., spacing of stitches and coaptation of the “edges”).

Training of basic surgical techniques for the handling of “skin lesions”

The simulation of different skin lesions, through drawings on peels of the chosen model, for students to make their respective diagnoses and/or treatment and repairs, makes the surgical training (resections with and without safety margins, incisional/excisional biopsies, and grafts of “skin”) more attractive and rewarding (Figure 3). Each of these procedures should be taught separately to the student, so that he can learn about every technique in details.

For example, by simulating a non-melanoma skin cancer, the student should do the marking of safety margins, the incision in the margins, the removal of the surgical piece and the correction of the defect with the graft or flap advancement/rotation (Figure 4).

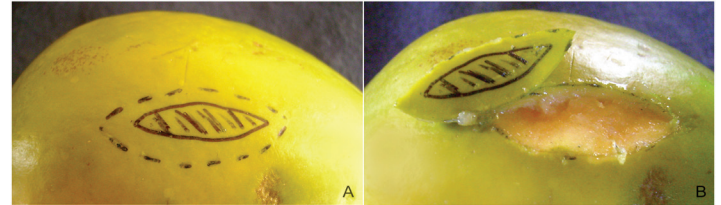


FIGURE 3 – Organic model for the training of basic surgical techniques. (A) Simulation of a “skin tumor” and (B) of its surgical resection. The “skin tumor” should be resected intact with full excision of thickness of peel fruit. This surgical procedure must be careful to avoid that the rind of the fruit becomes excessively damaged and/or torn.

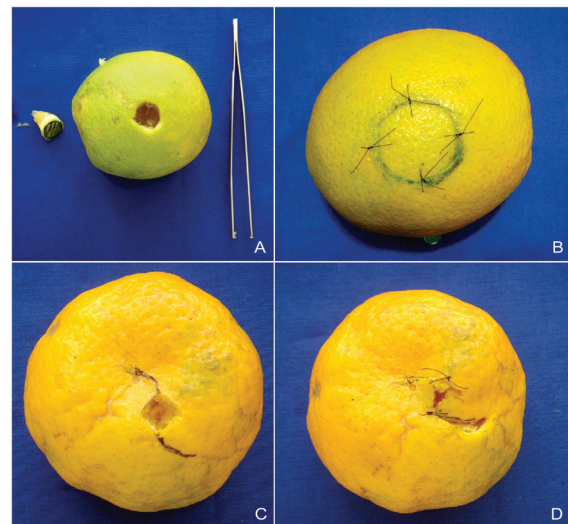


FIGURE 4 – Organic model for the teaching and learning of basic principles of reconstruction. Simulation of a correction of the (A) defect formed by placing a (B) “skin graft” or by a (C-D) “rotation flap”. The stitches were posed only to simulate the final result. It’s just a demonstration on the basic principles of “surgical flaps”, without placement of stitches for coaptation of the “edges”, since for this it is necessary to place tension on the “tissue”, and the model does not show this feature; the rind of the fruit/vegetable lacks the necessary elasticity to withstand this tension.

Feedback and evaluation

Feedback and evaluation are important to improve the learning of each taught technique. Feedback should be performed during and after each stage of training in the classroom, or at specific times scheduled after the training at home, in which the student will improve the taught fundamentals on his own. Instructors must evaluate each motion, searching for specific items that are not being adequately carried out (errors and failures) so that they provide a constructive feedback to students, enabling them to learn

from their mistakes and as a result they can acquire skills over time. The marking lines can serve as an evaluation parameter; one should point out and correct incisions outside them. Regardless of the feedback, it is important to encourage students to clear up their doubts during training and after completion of extracurricular tasks.

The Global Rating Scale⁶, which assesses students during performance of tasks in eight main areas (Table 1), can be used to evaluate and monitor the gain of students' abilities; each area presents a five-point scale (one corresponds to a minimum score and five corresponds to a maximum score), with a maximum total score of 40. Instructors can apply this scale at the end of each teaching session and in subsequent sessions they can follow the acquirement of students' skills and the specific points, among the eight evaluated ones, that deserve greater attention. The assessment can also be used to ensure that most students have trained and understood the proposed techniques. For an individual task, the candidate must achieve a score of 24 or more to be considered competent⁷.

Discussion

Although the acquisition of basic techniques and surgical skills have been only a part of the surgical learning, such knowledge is relevant to the general practitioners because it has important implications in the care of patients. Despite the importance of the topic, these skills are not acquired by a large percentage of students during their training³.

Since nowadays the traditional method of training based on practice with patients violates ethical and medico-legal issues⁸, there are simulation laboratories aimed at providing training techniques and surgical skills; these should be integrated into the educational program^{4,9} and have clearly defined learning goals⁹.

As was demonstrated that the training of novices in surgical skills laboratories can lead to improved technical performance during periods of increased attention demands¹⁰ and that the training in basic skills can lead to better performance of more complex tasks¹¹, students should practice in increasing levels of difficulty, from an individual⁹, deliberate, repetitive, and

TABLE 1 – Global Rating Scale^{6,7}.

Please rate the candidate's performance on the following scale:						
Respect for tissue	1	2	3	4	5	
	Frequently used unnecessary force on tissues or caused damage by inappropriate instrument use		Careful handling of tissue, but occasional inadvertent damage	Consistently handled tissues appropriately with minimal damage		
Time in motion	1	2	3	4	5	
	Many unnecessary moves		Efficient time and motion, but some unnecessary moves	Clear economy of movement and maximum efficiency		
Instrument handling	1	2	3	4	5	
	Repeatedly makes tentative or awkward moves with instruments		Competent use of instruments, but occasionally awkward	Fluid movements		
Suture training	1	2	3	4	5	
	Awkward and unsure with poor knot tying, and inability to maintain tension		Competent suturing with good knot placement and appropriate tension	Excellent suture control with correct suture placement and tension		
Flow of operation	1	2	3	4	5	
	Frequently stopped operating, seemed unsure of next move		Demonstrated some forward planning and reasonable progression of procedure	Obviously planned operation		
Knowledge of procedure	1	2	3	4	5	
	Inefficient knowledge of procedure. Looked unsure and hesitant		Knew all important steps of procedure	Demonstrated familiarity of all steps of procedure		
Final product	1	2	3	4	5	
	Final product of unacceptable quality		Final product of average quality	Final product of superior quality		
Overall performance	1	2	3	4	5	
	Very Poor		Competent	Very Good		
Maximum total score					(40)	
Total score:					()	
Overall on this task, should the candidate:				Fail	Pass	

participatory basis, rather than learning only by observation¹². The improvement of the technique is also possible based on performance errors¹³ without the worry of harming the patient¹⁴.

In these learning scenarios, there is a variety of simulators that must be seen as complementary tools since they provide the training and accelerate the learning curve of practical surgical skills, enabling a better use in further contact with patients; this contact represents the cornerstone of medical teaching⁴.

The available simulators vary with regard to the level of fidelity (realism) when compared with a live human⁴. The higher fidelity models, such as human cadavers, discarded surgical specimens in surgical procedures, *postmortem* and live animals, and virtual reality simulators, are more attractive to the trainees⁴. However, during the training of surgical skills with beginner students, it was demonstrated that the transfer of skills to the clinical environment is independent of fidelity¹⁵. Thus, low-fidelity models can reduce costs and provide more material and training opportunities without jeopardizing the results^{12,15}.

Because of the ethical/legal problems, the financial impact and the access difficulties inherent to training on human cadavers, live laboratory animals and virtual reality simulators, numerous bench models have been described as options for the training of surgical techniques⁴. Based on this, the main focus of this study is to propose the use of a bench model made of organic fruits or vegetables as a complementary alternative to teaching and learning; this model is accessible, portable, reproducible and of low cost and it can be used to complement the teaching of the surgery basis during medical education.

Similar organic models, with different indications, were described previously; they were made with oranges to the learning of skills in plastic surgery and debridement of necrotic ulcers, and with bananas, tomatoes and melons for the training of Mohs micrographic surgery and biopsy¹⁶⁻²⁰. The bench model and its proposed form of use in this study provide the teaching-learning for beginners in surgical techniques training and, as students acquire the pre-set requirements (simple skills), training can be enhanced with the teaching of more complex procedures in the model itself or in other simulators.

Backstage models and latex gloves are also reproducible, they are readily available and are inexpensive; therefore, they do not allow the training of procedures such as excisions and three-dimensional reconstructions. Synthetic materials such as polyurethane²¹ (Allevyn®), microfoam tape⁷ (3M®) and latex skin pad⁷ (Limbs & Things®) enable the training of these procedures; however, not in three-dimensional plane and they are difficult to acquire compared to vegetables and fruits.

The training of some surgical techniques could be carried out on models such as discarded surgical specimens²² or *postmortem* animals⁴. However, for the use of human organs, donation is required by the consent of patients and/or family, and also the existence of a collection/storage service in the institution itself. The *postmortem* animals need adequate facilities for storage and disposal, which often complicates and impedes training. There are also risks of infection in both cases (human organs and *postmortem* animal).

Nevertheless, the proposed bench model should not necessarily replace the teaching simulators used in different educational institutions. Indeed, the proposal is that it is complementary or adapted to the existing teaching. Some fruits (lemon, orange and banana), besides the three-dimensional spatial concept, allow students to have an idea of different layers and, even though being of low fidelity, they can mimic human skin – for example, the colored surface of peel may represent the epidermis, the white portion below may be similar to the subcutaneous cellular tissue and the fruit pulp can be compared to muscles.

Recently, a combination of self-directed training with feedback was described as the most effective method to teach basic technical skills, distributed intermittently over a pre-determined period (weeks)¹¹. In training, feedback can be immediate (during training) and/or later (after training) and it is associated with better and faster learning, and also with a greater store up of knowledge over time⁹. In order to obtain an even longer store up and a larger transfer of competences, it is preferable the interspersed practice with periods of rest, in contrast to the single exposure to the method²³.

Some limitations to this form of teaching (several days or weeks) would be: the higher financial costs, the shortage of faculty experts⁸ and the available time of faculty experts^{11,24}. One way to reduce costs would be the adoption of bench models such as the organic model proposed here. This model can be reused if stored in proper cooling conditions.

The practice outside the classroom, at home, can reduce the length of supervised training, while the feedback from the instructor would be just on the procedures already performed (e.g., sutures and incisions), reducing the time of supervision; for this, it is necessary that students have learned, initially under the direct supervision of the instructor. The comments generated by computers could also be an option; however, the retention of skills over time is significantly larger when learned through direct feedback from an instructor⁸. The incorporation of trained students^{25,26} and of trained nonsurgeon skills coaches¹⁴ could also reduce the time spent by faculty instructors in the teaching of

basic surgical skills. So, faculty surgeon would focus on teaching complex tasks and cognitive aspects of clinical training (decision making), that are not duties of the nonphysician skills coach¹⁴ neither to trained students²⁷.

In the teaching of surgical skills, the objective assessment is an important component, it is essential for evaluating the performance and evolution of the acquired skills and to provide feedback on training^{12,28}; and it helps to identify whether the proposed fundamentals have been learned by the student⁷. The student can attend the next stage of training since the predefined evaluation criteria are met¹². If it does not happen, another step in the teaching-learning should be held and a new evaluation should be carried out⁷.

Currently, the Objective Structured Assessment of Technical Skills⁶ is the gold standard for this evaluation²⁸, and it consists of a Global Rating Scale and a Task-Specific Checklist⁶. The Global Rating Scale adopted as an evaluation tool in this study is used to assess the generic aspects of technical performance and it has wide applicability without the need to develop specific lists for each procedure⁷.

The present proposal is structured only in the development of some skills and surgical tasks, it does not meet all the needs of students in training and it should include the acquisition of other skills (dissections, ligating structures, anastomosis and other)¹¹ that can also be trained in simulation environments²⁴.

Conclusion

The bench model made with fruits and/or vegetables, being simple, versatile, portable, reproducible, affordable, easy to purchase, and of low cost, is an option for supplementing the existing simulators for teaching and learning; it is aimed at preparing medical students before they can apply the surgical techniques in daily professional practice.

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Correspondence:

Rafael Denadai
Faculdade de Ciências Médicas
Universidade de Marília
Rua Paula Fabiana Tudela, 161
17516-707 Marília – SP Brasil
Tel./Fax: (55 14)3453-5456
silva.rdp@hotmail.com.br

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