ORIGINAL PAPER

Cirujano General
April-June 2018
Vol. 40, no. 2 / p. 70-77

Modification and evaluation of biological model of surgical teaching in extraction of lipomas in undergraduate

Modificación y evaluación de modelo biológico quirúrgico de enseñanza en extracción de lipomas en pregrado

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Key words:
Teaching, evaluation, lipoma, surgery, undergraduate.

Palabras clave:
Enseñanza, evaluación, lipoma, cirugía, pregrado.

ABSTRACT

Introduction: The use of biological models in surgical training, allow the development of several skills such as lipoma extraction, technique developed in porcine paw. There are several tests to evaluate such skills, like the ones established by Anaya and Serrano. **Objective:** Evaluate, an adaptation of Anaya and Serrano tests in lipoma extraction in porcine paw. **Methods:** This is a prospective, transversal, experimental and analytic study. The evaluation was performed in three different modules. The first one, approach the theoretical knowledge, the second one was evaluated with a practical/theoretical class, and the final module was a modification of the test proposed by Reyes-Arellano et al, using a marshmallow covered in fat as the biological model of the lipoma within the porcine paw. This innovative evaluation method was evaluated in 11 medicine students of third year. **Results:** In the first module 81.81% had sufficient knowledge on the subject, in the second one 84.46% approved, by the third module almost 90.90% achieved the lipoma extraction. A t-Student test was performed between approval and not sufficient groups, obtaining a statistical difference between both ($p \leq 0.001$). **Conclusion:** It was possible to apply the innovative modification of the lipoma extraction test model and make a statistical analysis of the results, concluding its' value.

RESUMEN

Introducción: *El uso de modelos biológicos en docencia quirúrgica permite desarrollar habilidades como la técnica de extracción de lipomas realizada en mano de cerdo. Existen referentes para evaluar dichas competencias como los de Anaya y Serrano.* ***Objetivo:*** *Evaluar con una adaptación del cuestionario de Anaya y Serrano la extracción de lipomas en mano de cerdo.* ***Métodos:*** *Se llevó a cabo un estudio prospectivo, transversal, experimental y analítico, dividido en tres módulos. El primero evaluó conocimientos teóricos. El segundo implicó una clase teórico-práctica y en el tercero se realizó una evaluación de habilidades técnico-quirúrgicas. Dicha evaluación se llevó a cabo a partir de un modelo modificado de Reyes-Arellano y cols., utilizando un malvavisco cubierto con gasa y caramelo en una mano de cerdo. Esta evaluación se aplicó a 11 estudiantes de medicina de tercer año.* ***Resultados:*** *En el primer módulo 81.81% tenían los suficientes conocimientos del tema, en el segundo módulo 84.46% aprobaron y en el tercer módulo 90.90% logra la extracción del lipoma. Se hizo una prueba t de Student entre los grupos aprobados y con calificación insuficiente obteniendo una diferencia estadísticamente significativa entre ambos ($p \leq 0.001$).* ***Conclusión:*** *Se aplicó el modelo de extracción de lipoma y se realizó un análisis estadístico de los resultados, concluyendo la viabilidad para evaluar al alumno.*

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Received: 22/02/2017
Accepted: 10/03/2018

INTRODUCTION

Lipomas are benign mesenchymal tumors arising from adipose tissue.[1] They are more frequent in females above the age of 40 and in overweight individuals.[2,3] In Argentina, they represent 1% of all benign tumors.[4] In Mexico, lipomas have been said to represent 17% of bone and soft tissue tumors;[5] lipomas of the skin may lead to complications from a previous disease or from their surgical management, such as hematomas at the incision site or mild hemorrhage.[6,7] Lipomas of varying size have also been reported in different organs, such as the esophagus,[8,9] heart,[10,11] peripheral nerves,[12] pancreas,[13,14] and others.

Models used to teach and develop surgical skills include physical media or virtual reality simulators[15,16] that can reproduce a certain phenomenon or situation, in order to practice repeatedly and to be able to act when faced with the challenges inherent in learning and dominating surgical techniques.[16-18] If we take into account the limitations, advantages and disadvantages of using biological or non-biological models to teach surgery to date, although the surgical and clinical abilities of those who begin practicing with these types of methods have been found to improve, there is no completely effective way to simulate all the situations that can be encountered in everyday clinical practice. Consequently, the effectiveness of training with teaching models has been questioned, as well as their usefulness, i.e., if they serve as a cognitive instrument or only to obtain manual skills.[19,20] Another training option is the use of biological models, either non-living tissues or live experimental animals. As an example, at the School of Medicine of the *Universidad Nacional del Noreste de Argentina*, a theoretical-practical course is offered to students during their last two years of training, involving a theoretical class on certain procedures to be performed, besides the clinical aspects of the condition under study. Subsequently, students advance to non-living biological models, which include different stations with animal organs and parts, such as bovine heart and lung and porcine cadaver, among others.[21]

Dávila-Serapio et al. evaluated 40 students to observe how many practice sessions were needed to satisfactorily perform basic laparoscopic surgical procedures on a live animal model, and concluded that five practice sessions were required for students to efficiently perform the procedure.[22]

Serrano-Martínez et al. evaluated the development of surgical abilities and skills for cataract surgery in ophthalmology residents and instructors who used the EyeSi® simulator, and described a system to evaluate students, consisting of modules divided into handling of instruments, handling of the ophthalmologic equipment, mastering of the technique, and management of complex procedures.[23]

Reyes-Arellano et al. proposed a surgical model for lipoma extraction by undergraduate students using a non-living biological model (pig foot), simulating the lipoma with a ball of Campeche wax (petroleum-derived wax) covered with gauze and inserted between the skin and subcutaneous tissue.[24] Villalobos-Flores published a non-living biological model to teach venous dissection to undergraduates, also using a pig's foot and Silastic® tubing with colored solutions, one blue and the other one red, to simulate vascular flow.[25] These models helped develop the skills, but learning was not evaluated. Anaya-Prado et al. published a pilot test to evaluate surgical competencies in general surgery specialty graduates; they completed a written and an oral exam and they were subsequently graded on their practical abilities in surgery by identifying laparoscopic instruments. The authors concluded that there is a very close relation between theoretical knowledge and surgical skills; their model also proved to be valid and reliable to evaluate surgical skills in a practical manner.[26] Roque-González et al. created a new instrument to evaluate surgical skills, using previously published literature on basic laparoscopic surgeries; the items evaluated were: placement of trocars, dissection of Calot's triangle, gall bladder removal, position of the surgeon, and handling of the camera. The instrument was validated with a Cronbach's alpha coefficient of 0.8, after being applied to 69 medical students.[27]

Cortés-González et al. published a review of a non-living biological surgical model for lipoma extraction, but in this model, the pig foot was infused with a reddish solution simulating the blood that runs through our system during surgical interventions and specifically, in this case, lipoma removal.[28]

Our aim was to use a modification of Reyes-Arellano's non-living biological training model (lipoma dissection in a pig foot) and evaluate undergraduate students with a validated system in modules and phases, based on the questionnaires developed by Anaya-Prado et al. and Serrano-Martínez et al., in order to measure the undergraduate students' achievement.

METHODS

This was a prospective, cross-sectional, experimental, and analytic study that

Table 1: Criteria for student selection.

Inclusion criterio	Exclusion criteria
• Individual studying for Bachelor of Medicine and Surgery (medical degree) at *Universidad Cuauhtémoc*, campus San Luis Potosí • Student of the fifth semester • Student who has studied and passed the subjects of pathology and surgical techniques • Any gender • Any age • Accepts participating in the study	• Student not in the fifth semester • Student who has not studied or passed pathology and surgical techniques • Student with over 20% days absent in the semester

included 11 fifth-semester medical students at *Universidad Cuauhtémoc*, San Luis Potosí campus. The study was conducted in the amphitheater and sampling was by non-probability quota *(Table 1)*.

The students' performance was described based on the questionnaire model designed by Anaya-Prado et al.[26] and the module system described by Serrano-Martínez et al.[23] Performance was evaluated in three modules, the first of which consisted of three phases: theoretical knowledge of the subject, knowledge of the material and knowledge of the surgical procedure. This first module was evaluated with an oral exam on theoretical knowledge, considered the pre-intervention exam. At the end of the first module, a general surgeon with over five years' experience teaching surgical techniques gave the students a theoretical-practical class, after which the students went on to the second module on efficacy, that evaluated their surgical skills *(Figure 1)*; this was the post-intervention evaluation. It was divided into six phases: antisepsis, local anesthetic infiltration, incision, lipoma dissection, wound closure, and operative time, using the model designed by Wulfrano Reyes-Arellano et al. with modifications of the material *(Table 2)*. Finally, the third module pertained to objective fulfillment and consisted of a single phase *(Table 3)*. The surgical procedure evaluated consisted in the separation of the pig foot's anatomical tissues, followed by removal of the lipoma (a marshmallow covered in gauze and a thin layer

***Figure 1:** Students working on module 2, efficacy, "surgical skills".*

of caramel). The simulated lipoma was inserted in the subcutaneous tissue. After its insertion, the area was infiltrated with iodopovidone, which stained the object to resect, modified its consistency and caused adherence of the marshmallow to simulate the dissection of fatty tissue. For the dissection, a lineal cut was made following Langer's line over the lipoma, the tissues were separated until the supposed tumor was accessed and the students proceeded to dissect it and extract it. Finally, the deep plane

Table 2: Materials used in the biological surgical model.

Modified materials	Materials used in Reyes-Arellano's model[22]	
• Marshmallow (sweet) • Caramel • Iodopovidone simulating the anesthetic • Absorbable catgut 3-0 suture • Non-absorbable nylon 3-0 suture	• Pig foot • Gauze • Soap • Water • Paper towels • Face mask • Surgical drape	• Gloves • Surgical cap • Surgical gown • 5 ml siringe • No. 20 scalpel blade • Minor surgery equipment

Table 3: Evaluation instrument, modified from the Anaya-Prado[24] and Serrano-Martínez systems.[21]

Name:				Yes	No
Module:	I. Theoretical education:	1. Knows the subject:	Knows the definition of lipoma?		
			Knows the physiopathology of lipoma?		
			Knows the surgical and anesthetic technique?		
			Knows the surgical complications?		
		2. Knows the material:	Knows the scalpel and the iris forceps?		
			Knows the Kelly forceps?		
			Knows the Halstead hemostatic forceps?		
			Knows the Farabeuf retractor?		
			Knows the Allis forceps?		
			Knows the Hegar needle holder?		
		3. Knows the technique:	Knows the technique for antisepsis of the hands and the model and how to place the drapes?		
			Knows the technique to anesthetize an area?		
			Knows the Langer lines?		
			Knows how to dissect and remove a lipoma?		
			Knows how to approximate wound edges?		
			Total		
	II. Efficiency:	1. Antisepsis:	Puts on cap, boots and mask?		
			Scrubs hands appropriately?		
			Puts on gloves appropriately?		
			Performs antisepsis of the model?		
		2. Infiltration:	Infiltrates the tissues correctly?		
		3. Incision:	Performs an adequate lineal incision?		
		4. Dissection:	Dissects the lipoma without liquefaction?		
		5. Closure:	Is able to close the wound?		
			Closes the wound perfectly?		
		6. Time:	Performs the procedure in 30-59 minutes?		
			Total		
	III. Objective fulfillment:	Lipoma removal:	Removed the lipoma adequately?		

was closed with absorbable suture and the superficial plane with non-absorbable suture.

Ethical aspects: The board of the School of Medicine of *Universidad Cuauhtémoc* was asked for authorization to carry out the research protocol. The protocol was accepted and approved by the Ethics in Investigation Committee of the *Hospital General de Soledad*, with registration number CEI-HGS-015-17. We proceeded to invite fifth-semester students to participate; those that verbally accepted were duly informed and asked to sign the informed consent form. Since the study was not a project involving the manipulation of morphological, physiological or genetic variables, it was considered a project without risk, pursuant to the General Health Act, and the guidelines for waste management were followed in accordance with the applicable system on Hazardous Biological Infectious Waste (HBIW).

Statistical analysis: For statistical purposes, results from the questionnaires were collected in Microsoft Excel 2013® software in which the students were tabulated. Later on, with the SPSS® software, version 23, an exploratory analysis was performed with the Shapiro-Wilk test to report the type of distribution of the variables, and if normal, the corresponding Student t-tests were applied.

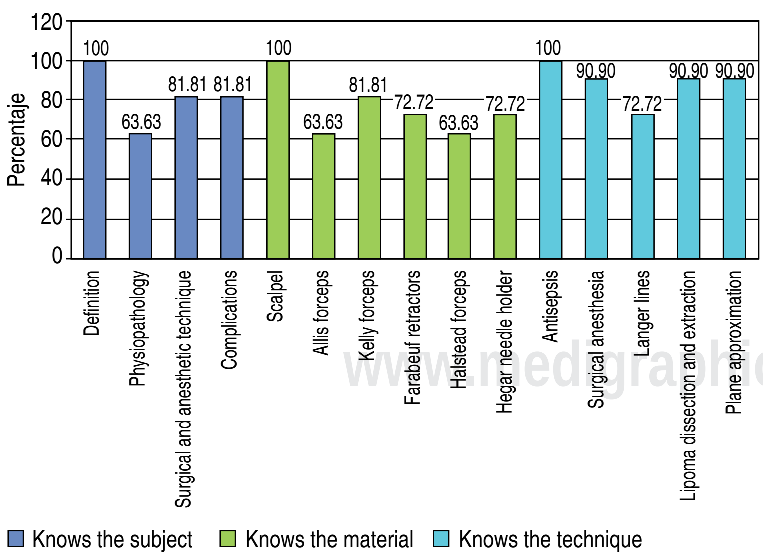

***Figure 2:** Results of the first evaluation module.*

RESULTS

In the first module, 81.81% of students had sufficient knowledge on the subject. The third phase of this module reported a higher mean, unlike the phase on knowledge of materials, which revealed the lowest mean value in the student sample evaluated *(Figure 2)*.

After the theoretical-practical class, the second *(Figure 3)* and third modules evaluating surgical skills were graded. In the second module, 84.46% of students demonstrated having good surgical skills. The phase with the highest percentage was that of antisepsis, and the worst was observed in cutting a lineal incision on the model. Finally, removal of the lipoma was evaluated as adequate if it was not liquefied and if wound closure was perfect; only one student was not able to extract the lipoma and did not close the wound perfectly.

The reported mean of the grades among the students who passed was 92.23, with a normal distribution according to the Shapiro-Wilk test ($p = 0.46$). There were no significant differences between the three modules *(Figure 4)*. The mean grade for students that failed was 43/100, so a Student t-test for independent samples was applied; the difference was statistically significant ($p < 0.001$).

The theoretical and practical modules were evaluated separately, revealing that the theoretical test did not show statistically significant differences by itself ($p = 0.72$).

DISCUSSION

The effort to link theory in books with practice when facing a patient has led to various means aimed at developing skills by using non-biological models such as the surgical drawer to practice knots,[29] live biological models, non-living porcine, bovine or cadaver models,[24,25] digital or virtual models[30,31] and synthetic tissue models.[32] This range of didactic aids prepares students, either at the undergraduate or graduate level,[33] to improve their performance when faced with a patient, but few of them describe a teaching model and its subsequent evaluation.

Our objective was to use a questionnaire based on the models created by Anaya-Prado

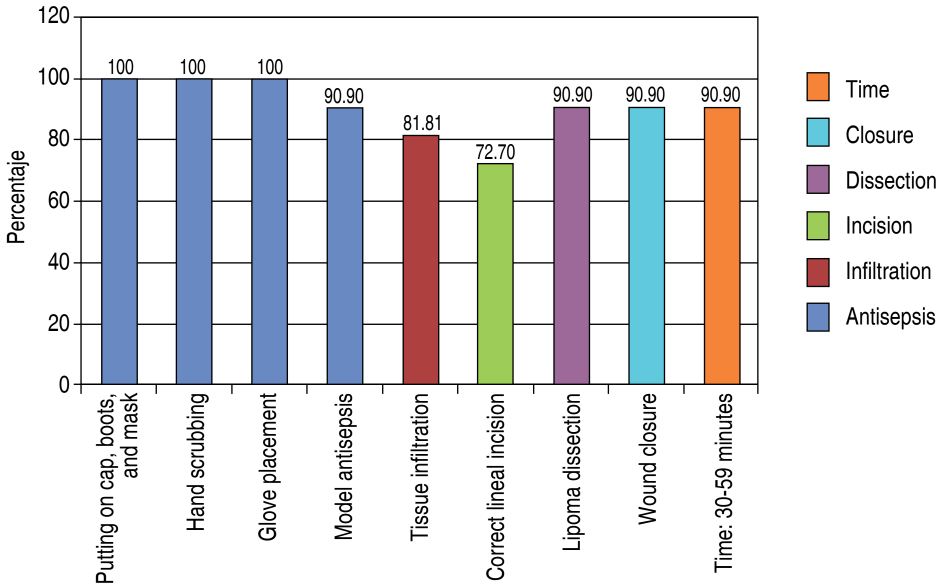

Figure 3:

Results of the second evaluation module.

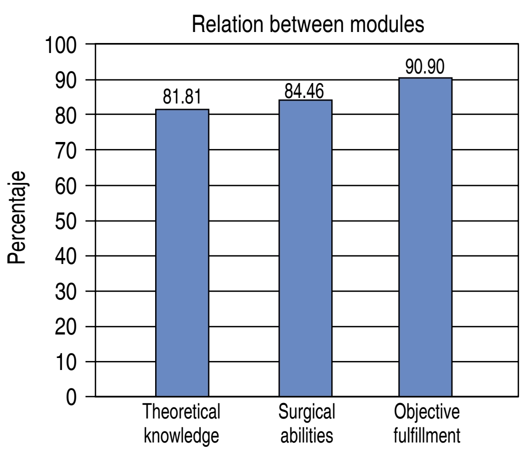

Figure 4: *Grades obtained in the three evaluation modules.*

et al. and Serrano-Martínez et al., who describe the evaluation process in phases. The former conducted a study that included two phases: the first phase was a written and an oral exam and subsequently, those who passed the exams were allowed to participate in the second phase, in which their surgical skills for laparoscopic procedures and identification of instruments were observed and evaluated.[26] In the study by Serrano-Martínez et al., an evaluation was conducted to compare between ophthalmology residents and attendings using a cataract surgery simulator and dividing the evaluation in modules.[23] By merging these two concepts (evaluating by modules and phases), it is possible to obtain greater organization and understanding, as well as a structured format, thus avoiding the usual biases inherent to the written examinations that are applied daily in educational institutions, and thus allowing to identify precisely all the necessary features for a health professional to be able to remove a lipoma in the practice described above. In our study, each one of the overall results, apparently similar among students, was divided into modules and several phases. Applying a modified version of the Reyes-Arellano model for lipoma dissection allowed us to use a non-biological strategy in an undergraduate experimental surgery laboratory that was effective enough to perform both the process of evaluation of previous teaching and the process of teaching and practical evaluation of each student. At the end, the overall results revealed that in the first module –the theoretical one–, in average 81.81% of students possessed adequate knowledge of the subject; in the second module, an average of 84.46% displayed the needed surgical skills to extract a lipoma; and in the third module, 90.90% were able to extract the lipoma perfectly and successfully.

We were struck by the fact that the student who was unable to extract the lipoma had some of the lowest grades. As a proposal for the future, we will try to increase the number of individuals so as to have a sample that makes it possible to establish a statistical difference. Our study was useful to apply the evaluation model in a non biological surgical practice model, and thus, close the circle of undergraduate education as Anaya-Prado et al. did at the postgraduate level.

CONCLUSION

We have been able to link two essential academic elements in the formation of health professionals in the surgical area: a simple, non-living biological model that can be used in any practice laboratory (lipoma extraction model in pig's feet), and a structured system for real and quantitative evaluation by phases that evaluates knowledge, the necessary instruments, mastery of the technique, and its practice in real life. It was possible to establish the quantitative evaluation of theoretical-practical knowledge by combining the systems designed by Anaya-Prado and Serrano-Martínez; had these been applied separately, they would have been less sensitive to point out students with inadequate technical surgical skills. It is important to include theoretical and practical tests in the usual academic evaluation. It was found that this test provides a more robust analysis of the student's skills and knowledge in the medical surgical domain.

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