Dermatology Surgery Training in a Live Animal Model

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Abstract

Background Surgical technique is an important part of resident training, which is the reason why various models have been implemented to acquire this skill. Animal models have been useful in teaching dermatologic suturing techniques. With the advancements in technology, simulators have been developed for these exercises, but at a very high cost. The use of pig heads and freshly killed animals have proven to be effective and low-cost. However, they do not reproduce skin pathologies with accuracy.

Objective To evaluate the effectiveness of a live anesthetized rat model to simulate skin pathologies requiring surgical excision in a dermatologic suture workshop for residents.

Methods We analyze the outcome of a theoretical and practical suturing workshop using live Wistar rats with 13 dermatology residents.

Results The residents showed an improvement in surgical maneuvers, suturing techniques, and in the use of surgical instruments ($p < 0.01$).

Conclusion The model proposed in the present study was economic, easy to obtain and to manage, and it portrays live and accurate skin response to manipulation. Therefore, it is effective for conducting surgical training sessions in dermatology.

Keywords
► skin
► skin surgery
► suture training model
► suture technique

Introduction

An animal model involves the use of one or more animals to reproduce a disease or a portion thereof, and when medical or surgical treatment is applied, the evolution is similar to that of a human. These models have facilitated advances in health research. Dermatology is a medical-surgical area that requires a solid theoretical foundation, as well as a considerable amount of adequate, quality practical training.[1–8]

A common practice for medical residents involved in the surgical field is to train for procedures with animal parts. This allows them to become familiar with the instruments and surgical material, and also provides them with the necessary experience and ability to perform on a patient.[9–12] Currently, many surgical residents still lack adequate training prior to handling patients.[13,14]

Some medical schools use the undergraduate period to conduct introductory courses on suturing techniques. The effectiveness of this pretraining and of the reinforcement during surgical rotation courses is uncertain. Studies have reported several forms of surgical training that include the use of animal anatomical parts or virtual reality simulators, both with advantages and disadvantages.[2–6]

The purpose of the present study was to use a live animal model in a dermatologic surgical procedures workshop for residents to evaluate its effectiveness. The focus was primarily on surgical skill and technique.

Material and Methods

A two-day course was designed, entitled “Skills in Dermatologic Surgery”, consisting of a theoretical and practical program. It

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was applied to 13 dermatology residents. The theoretical section included: histology and physiology of the skin, anatomy (with a focus on the importance of tension lines), the appropriate use of instruments, suture materials, and procedures/ techniques (fusiform incisions, forward flaps, subdermal suture, and repair of "dog ear" defects). The surgical practice was performed after the theoretical session at the Microsurgery Training and Research Laboratory of the Human Anatomy Department of Facultad de Medicina de la Universidad Autonoma de Nuevo Leon.

The surgical model used included adult Wistar rats of both genders, with a weight between 200 and 300 g, which had been previously used for other research purposes or protocols, and were programmed for euthanization. Rats exposed to radioactive or infectious agents were excluded. Prior to being placed under general anesthesia, all rats received an intramuscular (IM) dose of 0.15 mg/100 g of diazepam as a muscle relaxant. The general anesthetic, ketamine, was administered IM at a dose of 7.5 mg/100 g. The combination of a tranquilizer such as diazepam promotes muscle relaxation by counteracting the hypertonia produced by ketamine as well as producing amnesia. The evaluation of signs and tests was performed to ensure an adequate anesthetic plane before starting any procedure. A trichotomy of the ventral region was performed and the rat was fixed on a base and placed on the operating table of the laboratory.

The surgical instruments used in the course included straight dissecting forceps, blunt and sharp scissors, needle holders of different sizes, #3 scalpel handle with a #11 blade, and a cordless monopolar electrocauter. Sterile latex gloves were provided as well as consumables, such as gauze and swabs. Nylon sutures were used, varying in sizes between 5/0, 6/0, and 7/0, depending on the exercise, on the region being worked, and on the techniques used for suturing.

Each of the procedures was subjectively graded by the instructors as bad, good, or excellent based on technique, speed and result, on the first and second days of the practice. Time was measured in each of the procedures of the first day and compared with that of the second day.

The suture skills were graded by three external judges, all surgeons with knowledge of dermatologic surgery. The allocation of specimens and the surgical team among the residents was random.

Statistical Analysis

Mean and standard deviation (SD) were calculated for quantitative variables. The Kolmogorov-Smirnov test was used to check whether the time variable development of the surgical techniques followed a normal distribution. For significant differences in the surgical time between each day, the student *t*-test was applied for dependent samples. The scores obtained by the students in both times were compared using the Wilcoxon test. All analyses were performed using SPSS 17.0 for Windows (SPSS Inc, Chicago, IL, USA). The significance level of the test used was $p = 0.05$ for two-tailed tests and a β1-power = 80%.

Results

A theoretical section was presented at the beginning of the course, and the surgical practice was performed subsequently. The practice maneuvers began with how to handle surgical instruments and with suture technique exercises on inert material. The animal practice was performed on adult Wistar rats.

Dermatology residents ($n = 13$) of both genders, with a mean age of 26 years (range 23–29), were included. None had completed a surgical program, but all had performed minor surgical procedures in the dermatology service.

The exercises consisted of several types of wound closure. Fusiform incisions were made and closed with separate stitches. The technique consisted of inserting the needle perpendicular to the skin, crossing the full thickness of the dermis and continuing on the opposite side of the wound, checking the symmetry, width, and depth of the stitches,. The edges of the wound remained slightly everted, so that natural traction of the scar could occur (►**Fig. 1**).

Similar incisions were done to practice continuous suture, a technique in which a series of simple suture points were placed in succession and uniform stress was distributed along the suture line. For the subdermal continuous suture technique, the stitches were placed successively through the subcutaneous tissue on opposite sides of the wound, and the knots were tied at the ends of the wound (►**Fig. 2**). The reproduction of flaps progress techniques was also possible, with similar results.

All 13 residents demonstrated knowledge of the use of surgical instruments and suture material. The statistical analysis was classified by results at the beginning and at the end of the course. The evaluation of medical residents

Fig. 1 Fusiform incision to join edges with separate stitches.

Fig. 2 Subdermal continuous suture stitches are placed through the subcutaneous tissue (arrow).

was better on the second day, primarily in senior students. However, all participants demonstrated a statistically significant improvement both in skills and in procedure performance (►**Table 1**).

Discussion

Practical training is essential in any surgical specialty. Surgical simulators are an established part of training and have been used as part of the objective assessment of surgical skills for residents and doctors in many institutions.[15,16]

Artificial skin models that simulate several diseases have been used. However, they are expensive or difficult to obtain in third world countries, such as Mexico. Pigskin has also been used, as it is easy to obtain, inexpensive, and its texture and consistency are similar to those of human skin. The ideal and most used model is pig leg. However, because of its cylindrical morphology, it is not suitable for more complex procedures. Pig heads, however, have demonstrated better results for training exercises involving grafts, flaps and even dermal fillers, according to Chen et al.[9]

These models have been widely used in basic sutures workshops or can even be modified for deep cysts models to train medical personnel in these pathologies.[6–9,11,12] Porcine models are a suitable option. However, the anatomical parts available are not always the best for complex procedures because they are inert tissues lacking the characteristics and the response of live tissue, such as temperature, elasticity, firmness, texture, and vascularity.

With the technological advances in biomedical sciences, virtual reality devices will make animals and artificial models obsolete.[5,10,11,13,15] However, it will take time and experience for them to be considered the standard methods for surgical training. Their cost is also an important issue because many institutions and third-world countries cannot afford to buy and maintain these simulators.

Some institutes have surgery training programs using live pigs, providing an invaluable tool in teaching cutaneous surgery. These are also used for procedures in other systems, such as the gastrointestinal (porcine gastric ulcer with active bleeding), to train residents in superior digestive surgical endoscopies. They are also used in other modalities, such as dermal application of carbon dioxide (CO_2) and other chemical treatments for aesthetic purposes. However, the hypovascularity of pigskin makes it drier and represents an important difference to human skin.[9,17–20]

Rats and mice have been the most popular model for research, especially in the study of skin, such as wound repair models, due to its similarities to human tissue and its proven economical maintaince.[21] The use of rats from previous studies also helps in reducing the cost. Although some differences exist between mouse skin and human skin, the use of mouse skin for cutaneous surgery training workshops have been statistically proven to bring benefits to the surgical training.[8]

A murine model provided an important tool for training 13 dermatology residents. They demonstrated a greater identification with the surgical material, as well as an improvement in the most frequently used surgical suturing techniques.

After the workshop, the residents reported that the exercise helped them to gain experience and confidence in their surgical ability, as well as to perform procedures they did not wish to perform for the first time on patients.

Table 1 Results of the time taken to complete the exercise test for each surgical technique during the first and second day of the course

	n	First day $\bar{x} \pm \mathrm{SD}$	Second day $\bar{x} \pm \mathrm{SD}$	t	*p*
Exercise 1 Instrument use	13	13.08 ± 1.61	9.08 ± 1.32	10.198	< 0.01
Exercise 2 Fusiform incision	13	18.62 ± 2.22	15 ± 1.91	5.514	< 0.01
Exercise 3 Flap progress	13	23.31 ± 2.32	19.38 ± 2.66	6.081	< 0.01
Exercise 4 Subdermal suture	13	24.00 ± 2.12	19.38 ± 3.59	4.924	< 0.01
Exercise 5 Dog ears defects	13	5.92 ± 0.76	4.38 ± 0.96	5.734	< 0.01

Abbreviations: t, time; *p*, statistical significance set a $p < 0.05$; $\bar{x} \pm \mathrm{SD}$, mean plus/minus standard deviation.

Conclusions

The model presented in our work uses a live animal, reproducing a similar situation to that of a surgical procedure on a patient. The practitioner focuses not only on the design of an incision or on the repair of a defect, but also has de advantage of the feeling and of the consistency of the skin and of the deep tissues, while practicing bleeding control and the use of electrocauterization. This is an economic and easily obtainable model that provides real characteristics and should be considered for conducting training workshops of surgical skills in dermatology.

Conflicts of Interest

The study was approved by the Ethics Committee of the University Hospital under the key AH10–003. All animals were treated and euthanized following the Official Mexican Norm NOM-062-ZOO-1999 regarding the use and management of laboratory animals.
The authors report no conflict of interest with publications in the present study.

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