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Using of Chicken Eggshell in the Microneusurgical Training Model for Microdrilling of Sella Floor

*Cengiz Cokluk**

Department of Neurosurgery, Ondokuzmayis University, Turkey

Abstract

Objective: Repetitive practicing of microneurosurgical techniques in experimental laboratory using real surgical instruments on training models is extremely important before starting the real surgical interventions. In this experimental study, it was created a laboratory-training model for microneurosurgical drilling of delicate and thin cranial base bones.

Methods: Twenty-five boiled chicken eggshell for five minutes were used for this study. The difficulty and suitability of the model was evaluated in terms of the usability in the training of microneruosurgical microdrilling. The objective criterion for the evaluation of the difficulty of the procedure was the protection of the membrane during the procedure. The suitability of the procedure was evaluated within three groups as bad, good, and perfect.

Results: In four (16%) eggshells, the difficulty of the microdirilling was evaluated as difficult. Fifteen (60%) of the eggshells were microdrilled with easy procedure. The remaining six (24%) of the eggshells microdrilling was evaluated as very easy. The suitability of the model was evaluated as bad in three (12%) of the eggshells. The suitability was found as good in 16 (64%) of the eggshell. In the remaining three (24%) of the eggshells microdrilling, the suitability of the model was evaluated as perfect.

Conclusion: Consolidation of the surgical practice in a laboratory setting, grasping and using of microsurgical instruments, can be repeated in several times in this model. We believe that this model will contribute to the practical training of microneurosurgery.

Keywords: Microneurosurgery; Training of microsurgery; Microdrilling; Eggshell

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Correspondence:
Cengiz Cokluk, Department of Neurosurgery, Cengiz Cokluk, Ondokuzmayis University, Samsun, Turkey, Tel: +905352095913; E-mail: cengizcokluk@yahoo.com

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Introduction

Theoretical and practical training of microneurosurgery includes many difficult, time and ability requiring steps in neurosurgical period of life [1,2,3]. Specific microneurosurgical techniques such as properly using of the operative microscope, holding and grasping of the microneurosurgical instruments, proper microsurgical technique of the opening of the arachnoid membranes, safe and delicate neurovascular dissection, and carefully and properly microdrilling of the cranial base bones should be learnt before taking place in front of the patient's head in the operating room [1,4-7]. Theoretical knowledge, practical techniques, and microsurgical operative disciplines are mainly provided during the residency years of neurosurgical education [1,3]. These basic and essential practicing gained during the residency years are not sufficient to safely do some kinds of microneurosurgical interventions to the patients [4-6]. Because of these reasons many neurosurgeons interested in microneurosurgery try to gain some additional and advanced progress in the improving their microneurosurgical ability [1,3-7]. Spending of time in experimental microsurgical laboratory to practice some kind of microsurgical models such as dissection and suturing of the rat external carotid artery, dissection and evaluation of the abdominal vena cava of rats, suturing of the plastic glove materials by using microforceps under the operating microscope, drilling and dissection of some cadaveric bone materials are essential improving and gaining of advanced microneurosurgical practical techniques [1,3-7].

Removing of the bony structures located in the cranial base are necessary during the intervention of some kind of operations such as intranasal transsphenoidal hypophysis surgery [2]. In the other hand, intradurally and/or extradurally removing of the thin and delicate bony structures overlying of some important and critical neural and vascular structures needs advanced microsurgical microdrilling techniques before performing of operations. Using of the microsurgical instruments (in our case using of the electrically powered high-speed microdrill with its different tips) on the

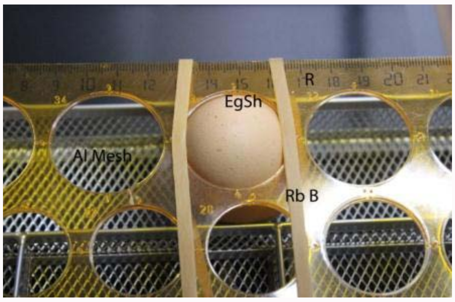

Figure 1: This figure shows the details of the experiment.
Al Mesh: Aluminum Mesh Tray; EgSh: Eggshell; RbB: Rubber Band

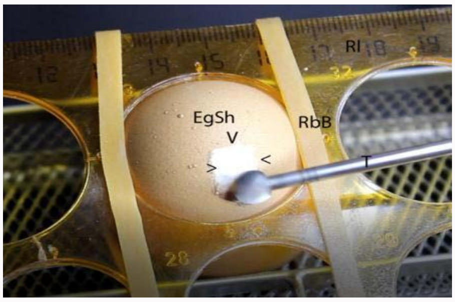

Figure 2: The microdrilling of the eggshell.
EgSh: Eggshell; RbB: Rubber Band; Rl: Ruler, the arrows show the microdrilling area

thin and delicate bony structure of the Sella Turcica floor covering over the hypophysis, bilaterally internal carotid artery, unilayer of the dura mater, circular venous sinus, and bilaterally the medial wall of the cavernous structure are extremely important without any surgical injury during the bony microdrilling step of the operation [2].

In this experimental study, it was developed a practical model by using chicken eggs in the microsurgical training model for drilling of the Sella Turcica floor. Anatomically, the outer shell of the chicken eggs is an eligible model for the bony structure of sellar floor. The delicate membranous structure located under the eggshell is and acceptable and appropriate model for the uni-layer dura mater located under the bony structure of the Sella Turcica floor. The structural material located inside the chicken eggs turns solid materials after the boiling of the chicken eggs within the boiling water [8,9]. It is very easy and cheap materials to find in common daily of life.

In this experimental modeling study, it was evaluated that the removing of chicken eggshell using high-speed microdrill in the contribution of the using and handling ability of the microdrill. In the other hand, it was also evaluated that the feasibility of the using of this model in the micro drilling of the Sella Turcica floor in clinical microsurgical practice. Experimental findings, difficulties, practical methods and suggestions were discussed under the light of the literature.

Materials and Methods

This study was performed in Microneurosurgery laboratory of Neurosurgery Department, Faculty of Medicine. Thirty-five chicken eggshells were used in this experimental feasibility study. The eggs were boiled for five minutes before processing. After five minutes, the eggs were removed from boiling water and allowed to cool in room temperature. Aluminum wire mesh tray was used for stabilization

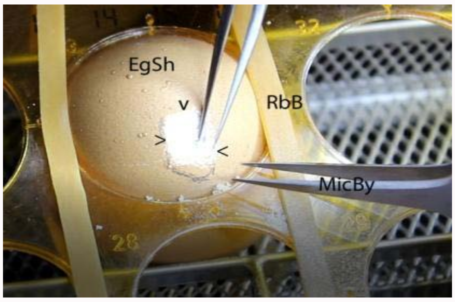

Figure 3: This figure shows the dissection and separation of the eggshell membrane.
EgSh: Eggshell; RbB: Rubber Band; MicBy: Microbayonet, arrows show the dissection area

of the eggs under the operating surgical microscope (Zeiss Surgical Microscope, Germany). Rubber elastic bands were used for fixing of the eggshell in the aluminum mesh tray (Figure 1). The rectangle plastic ruler with circular openings over its large flat surface was used for more stabilization and fixation of the eggshell under the surgical microscope before starting the procedure (Figure 1). Using pencil, the operating area was marked before starting the microsurgical drilling procedure. Using high-speed microsurgical drill (Midas Rex® Legend® Electric System, USA), the superior, inferior and lateral surface of the chicken eggshells was micro-drilled with proper attachment (Small Bore Variable Exposure Attachment) and tools (5 mm ball and 5 mm ball diamond) of the Midas Rex® Legend® Electric System for opening of the burr-holes (Figure 2). Interior membranous dissection and separation was performed using micro-forceps, micro-dissector and micro-hook (Figure 3).

Difficulty and suitability of the procedure was analyzed in the evaluation of the model for sella floor drilling. Difficulty of the procedure was divided as four degree (very easy, easy, difficult, and very difficult) in according to the description of the performer (CC). The main objective criterion for the difficulty of the procedure was described as the protection of the eggshell membrane along the performing of the procedure. The suitability of the procedure was also evaluated within three groups as bad, good, and perfect.

Results

In four (16%) eggshells, the difficulty of the microdirilling was evaluated as difficult. Fifteen (60%) of the eggshells were microdrilled with easy procedure. The remaining six (24%) of the eggshells microdrilling was evaluated as very easy. The suitability of the model was evaluated as bad in three (12%) of the eggshells. The suitability was found as good in 16 (64%) of the eggshell. In the remaining three (24%) of the eggshells microdrilling, the suitability of the model was evaluated as perfect. Microsurgical drilling of the superior, inferior and lateral wall of the chicken eggshell, and enabling repetitive drilling are indications of the suitability of the material. There is airspace under the inferior end of the eggshell. The microsurgical drilling of the inferior end without membranous rupture is more difficult in comparison with microdrilling of the superior tip. All treated surface should be equally microdrilled for the successful drilling process. Outer layer of the chicken eggshell is harder than inner layer because of its amorphous calcium carbonate content. The inner layer is softer than outer layer and it has some similar properties to normal bones. Microsurgical drilling of the eggshell without any membranous injury located just inner surface of the outer eggshell is an indication of the successfully surgical microdrilling process. Microforceps, microhook, and microdissector may also be used in the identification, separation and dissection of the inner membranous structure to imitate microsurgical steps (separation and dissection of the dura mater). Microdrill tips with different features and sizes may be able to use in this model. The rotation speed of the microdrill and the effect of rotation speed on the microdrilling process may be evaluated in this experimental model.

Discussion

Regional microneurosurgical neuroanatomy and microsurgical instruments should be known and recognized for a safe microneurosurgical intervention [1]. It is crucial the using of these instruments with appropriate microsurgical technique [1]. It is imperative that surgical techniques should be repeated several times on appropriate models to successfully maintain and terminate microsurgical interventions [1]. Before a real operation performing on human beings, it is extremely necessary that understanding of abilities of some sophisticated devices to be used in the microneurosurgical intervention, and in addition, it is required for the person to develop his or her own abilities and to create integrated surgical techniques [1,3-7]. Microneurosurgical operation performed on human subjects can be properly staged. Each step carries unique features. In training of microneurosurgery, stepped or staged microsurgical training is the most commonly used learning methods. Vascular end to end, end to side, side-to-side anastomosis, aneurysm clipping, and sylvian fissure dissection may be given as example for staged microsurgical training [3-7]. In this model, using of chicken eggshell microdrilling is proposed as a training model for delicate and thin cranial base of the Sella Turcica.

First essential feature, in order to speak of an appropriate and successful model is the partial similarities of the represented model. On the other hand, another important issue is the easily obtainable and cheap properties. Other important issues are the short and easy preparation period of the model before using under the operating microscope without including any complicated steps. Repetitive operations on the model in various ways can be accountable as a positive advantage. When taking into consideration the ethical issues, live models, in addition to the above mentioned disadvantages, compromise some problematic limitations in experimental practice. It can be seen some advantages when we evaluate the eggshell under the light of the parameters detailed above. Eggshell has some similar features in comparison with the floor of the Sella Turcica in terms of size and shape.

The eggshell is an inexpensive material that can be obtained easily because the egg is a food source consumed through nutrition. The eggshell can be used as an experimental material after boiled for five minutes and then cooled. The same material is suitable for microdrilling without boiling. The advantage of boiled egg is that it can be processed many times on many places because it is a solid material. This can be regarded as a positive advantage. Because the egg is not a living model, there is no need for local ethical committee permission. So there are no ethical restrictions in this model in comparison with live models.

When we think of all these features together, the eggshell should be regarded as a suitable model in the experimental microneurosurgical microdrilling of the floor of the Sella Turcica training model. The eggshell has some rigid and harder features in comparison with human bone due to the extensive amount of amorphous calcium carbonate and the limited amount of the collagen material in the contents of the outer shell [8,9]. This feature can be considered as a disadvantage of the model.

When the egg is not boiled the egg content is completely liquid, so care must be taken that the membrane under the eggshell is not damaged during the microdrilling process. If the egg is boiled for three minutes, the outer layer of the egg content will solidify and the inner layer will become a cystic pattern filled with liquid colloidal material. It is also important to recognize the specific surgical instruments used in this proposed model and gain some practice by trying them out in various ways. High-speed microdrill can be accepted as the top of these instruments. Allowing microdrills to be used in this experimental model with different tips and types makes the person more familiar with this device. The process of reducing and increasing the turning speed of the microdrill and observation of the events to occur during this process can be accounted as the other purpose of this practice. During the chain of processing, the process of the removing of the most outer layer from the membrane located under the eggshell is another important step. The use of the microhook in the dissection of the inner membrane from the rigid outer shell can also be practiced. Using of the microdissector to produce pressure to the membrane for separation can be used for practicing.

Conclusion

Removing of the thin and delicate bone structure of the cranial base by using micro drilling is one of the most important steps of the surgical intervention in the microneurosurgical practice. Before starting the surgical intervention performing on live subjects, this process should be practiced several times on practical training models such as in this proposed model in several times until practically learning. In this experimental study, chicken eggshells are proposed as a practical and viable model. Consolidation of the surgical practice in a laboratory setting, grasping and using of microsurgical instruments, can be repeated in several times in this model. We believe that this model will contribute to the practical training of microneurosurgery.

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