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Research Article:

The Effects of Skill Lab Programs in Training of Neurosurgery Residents

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ABSTRACT

Background and Aim: Nowadays, surgical educations and training experience new problems. Legal issues and patients' rights are a matter of concern in educational hospitals. The high cost of modern technology-based surgical education has also made the training of the residents increasingly difficult. Therefore, it seems that new approaches in the training of surgeons are necessary. One of the strategies for this purpose is the establishment of clinical skill lab programs.

Methods and Materials/Patients: In this study, 4 clinical skill lab workshops were designed to increase the residents' clinical skills in a very low-cost setting. We recruited 13 residents in this study. The workshops were categorized as craniotomy, working with a microscope, tissue resection, and microsurgical dissection. After the workshop, the residents and their attending physicians were evaluated by answering the questions about the workshops.

Results: According to the evaluations, both residents and their attending physicians believed that these workshops were significantly effective in enhancing these skills.

Conclusion: It seems that adding clinical skill lab workshops into the residency curriculum can improve the quality of their training and avoid the stressful environment of an actual operating room and the possible legal problems. Also, residents can learn more in a shorter time and have better self-esteem for training in neurosurgery.

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Highlights

- This study shows that a skill lab program can enhance the residents' ability in surgery.
- Surgical planning can be more precise with a skill lab program.
- The residents can learn more in a shorter time and develop self-esteem for training in neurosurgery.

Plain Language Summary

Surgical education and training programs usually encounter legal problems including patients' rights as well as other issues such as the high costs of technology-based surgical education. In this study, 4 clinical skill lab workshops were held to increase the residents' clinical skills in a very low-cost setting. After the workshops, the residents and their attending physicians were evaluated by answering the questions about the workshops. It seems that adding clinical skill labs into the residency curriculum can improve the quality of the residents' training and reduce the related stress of an actual operating room environment and possible legal problems.

1. Introduction

William Stuart Hallstead founded the world's first codified surgical training program at Johns Hopkins Hospital in 1889 [1]. Since then, various programs have been designed and implemented in different parts of the world for better residency training.1However, higher demands for the patients' safety and improving the efficiency of the hospital systems have limited the application of these programs [2]. These demands have led surgical training programs to be under scrutiny and forced them to improve their effectiveness. To meet these demands, one strategy is to use operating room simulations and incorporate the resident practice into simulated environments in their curriculum [3].

There is no doubt that the best learning environment for residents is a real operating room environment with an actual patient. However, this training can have many limitations, such as ethical problems, financial constraints, forensic problems, and time limitations of residency courses. Because of these problems, it seems prudent that basic surgical skills be acquired outside the operating room [4].

This strategy is increasingly needed to better align with new educational laws and advances in surgical complex devices. Skill lab workshops can provide a safe and controlled environment to enhance these skills. Anatomical dissection workshops, for example, are part of the training of neurosurgeons who intend to master microscopic surgical techniques [5, 6]. Although many neurosurgeons have used these workshops to enhance their skills, these are absent from the residency training program. However, it should be noted that there are some obstacles to developing these training programs, including the allocation of appropriate space, budget, and equipment [7]. In this study, we designed a structured educational system to prepare residents for basic surgical skills like craniotomy and microscopic-based neurosurgery. These basic skills are required for neurosurgeons. They should be practical, simple, and cost-beneficial while enhancing resident skills very well.

2. Methods and Materials/Patients

In this study, 13 junior residents (the first, second, and third years) participated in the skill lab workshops for 3 months. Four skill lab workshops were designed, and all residents participated in them in turn. These skill lab workshops included high-speed drill craniotomy, practice with a surgical microscope, tissue resection, and microscopic dissection.

High-speed drill craniotomy: This 2-hour workshop was held for two groups separately. The residents are expected to practice craniotomy and use high-speed drills in this workshop. For this purpose, some coconuts were purchased, and their outer layers were shaved. Then different shapes were drawn on the hard shell of each coconut. Residents were asked to fix the coconuts on the edge of the table by Mayfield. In this procedure, they should assume that the hard coconut shell is a skull and the thin brown shell underneath is dura. Next, they should drill and try not to damage the shell. To do this, the residents first had to pierce a point of the drawn line

with the burr hole and then continue to draw the final shape without damaging the underneath tissues. In this workshop, residents should try to cut the drawn shape accurately and skillfully.

The residents worked in groups of two. The second person took the task of irrigating the drill site. The residents should take into account the importance of this task. If the irrigation is insufficient, the drill may break and damage the underlying tissue due to overheating of the blade.

Working with a surgical microscope: The workshop was held individually for 2 hours. The purpose of the workshop was to gain the practical skills of working with a surgical microscope and to improve the accuracy of residents' fingers and hands movements under the microscope. For this purpose, the operating microscope was placed in a separate room when elective surgeries were not performed in the hospital. To practice with the surgical microscope, some bell peppers were fixed on the table in the operating room. The residents were asked to make a 3-cm cut at the end of the pepper and try to cut a seed (without damaging it) without stretching the edges of the cavity. They were then asked to do this with a surgical microscope. Residents in this exercise should be familiar with different parts of a microscope and perform the relevant operations, including shifting, zooming, focusing, vision modification (if necessary), and balancing. It is essential to use a microscope in a stress-free position so that the surgeon can operate with maximum precision and comfort. Therefore, the workshop emphasized being in the appropriate position. Then the residents had to choose the seed under the microscope by using forceps and bypass and remove it without damaging the pepper surface or other seeds.

Tissue resection: The workshop was held individually for 4 hours. The purpose of this workshop is to practice tissue resection in the brain without damaging the surrounding structures. The workshop can also help the resident better understand the concepts of actual surgery. In this workshop, the residents must remove a gyrus without damaging the surrounding gyri. Then, they should resect a sample of an artificial tumor. The tumor was made by injecting agar into the brain tissue. Residents must have passed the previous workshop (working with a microscope) before attending this workshop. This workshop requires a tissue similar to the human brain—we used the sheep brain, which is very cheap and available. Given the dangerous biomaterials in sheep's brains, the tools used in the workshop cannot be returned to the operating room. Thus, we used old operating room tools that had already been replaced and put them outside. The workshop supplies included a microscope, fresh sheep brain, suction, scalper No. 11, micro-detector, micro-hook, micro-forceps, syringe, and agar-agar gel.

First, we fixed the sheep's brain on the table. Then, we selected a gyrus with a microscope and the tools listed above and asked the resident to resect that gyrus without damaging the surrounding tissues. Details of the procedure were taught to residents by an attending physician at the workshop. For the next task, we had to create an artificial tumor in the sheep's brain. To make a tumor, we poured 2 tablespoons (about 30 mL) agar-agar powder in 50 mL boiling water. After complete dissolution, the solution is allowed to cool down so as not to burn the hand. Then (before stiffening), about 2 to 3 mL of the solution was quickly removed with a syringe and tangentially injected with a high gauge needle into the brain tissue. If the injection is not tangential, agar may be injected into the ventricle. The other steps were the same, and the resident could practice brain resection of the tumor. Obviously, the resident should extract the maximum amount of tumor without the slightest damage to the surrounding tissue.

Microscopic dissection: The workshop was held individually for 4 hours. The purpose of the workshop is to improve the accuracy of residents' finger and hand movements under the microscope during surgical resection. In this workshop, chicken wings were used to simulate microscopic surgery. As the equipment used in this workshop could be re-sterilized and returned to the operating room, this workshop was held in the operating room. Supplies for this workshop include a surgical microscope, chicken wings, Dumont forceps No. 5, surgical scissors 10.5 cm or scalpel number 11, micro scissors, 6.0 to 9.0 sutures, and needle holder. The residents should already have attended the last two workshops and then participate in this workshop.

As mentioned in the previous workshops, first we should fix the chicken wing on the table in proper condition. Then, the resident should find the brachial artery between the chicken wing muscle muscles. To do this, he must open the skin in the presumed direction of the artery with scissors and separate the muscle blocks for dissection. Here, the artery can be found under a fascia surrounding the artery with connective tissue. Next, he should open the fascia under a microscope and remove other tissues from the artery. For this purpose, it is advisable to force the tissues by forceps and carefully remove them from the artery with scissors. The resident

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should continue to separate at least 5 mm of the mentioned artery completely from the surrounding tissues. He has to pass a piece of paper or white glove beneath the artery to create a suitable work environment. Then, the resident should remove the remaining adventitia tissue. At this point, the resident should cut the artery with scissors and try to stitch it with a 9.0 suture with the guidance of attending physician.

To evaluate the efficacy of these skill labs, we designed 2 questionnaires which are scored on a 5-point Likert-type scale for residents and attending physicians. The answers and scores consist of "strongly agree" (5), "agree" (4), "neither agree nor disagree" (3), "disagree" (2), and "strongly disagree" (1). Residents were asked to answer according to their personal experience of participating in these skill labs. Also, attending physicians completed their questionnaire according to residents' improvements that they noticed. At last, the average score of each question has been reported.

3. Results

The main goal of these lab workshops was to increase residents' skills in using surgical techniques and to gain more experience in using craniotomy and microscopic surgery. After the workshops, the residents and their attending physicians were evaluated regarding the benefits of the workshop. The improvement of residents to use a surgical microscope and do microscopic resection, according to their statement, was significantly high (the average score was 4.61 of 5). Also, all residents were satisfied with the practice of suturing the chicken wings and said they were eager to practice it again. The mean score was 4.84 for this skill lab. The residents believed that the increase in using surgical instruments skills for craniotomy was less significant, and the mean score of this workshop was 3.92.

Regarding whether these workshops are helpful for residency training before entering the operating room, the average obtained score was 4.23. On the other hand, this score for the benefits of training surgical techniques and concepts was 3.38. The results of residents' questionnaires are presented in Table 1. The result of the question of "residents' skills in microscopy and related techniques had increased significantly or not" that was scored by attending physician was 4.8. The answers of attending physicians to questionnaires are presented in Table 2.

The increase in residents' skills was significant regarding the use of surgical microscopes and microscopic procedures, very thin surgical sutures, and high-speed surgical drills.

4. Discussion

Mahmut Gazi Yasargil once said he had a mental block for skull base surgery when he became a neurosurgeon. He felt uncomfortable and without experience with skull base anatomy and the use of high-speed drill technology. However, he gained good experience in clinical skills workshops and could overcome his inexperience [6]. Clinical skills lab workshops appear to be effective in surgical education. However, it is difficult and costly to establish them in medical education centers with no surgical clinical skills workshops [7]. In this study, we designed four practical clinical skill workshops for neurosurgery residents with minimal equipment and costs. These workshops can enhance residency skills beyond the constraints and problems of the actual operating room situation. They give the residents a better understanding of the surgical approach, especially for surgeries that occur less during the residency period; they can maximize learning from those surgeries. In different studies, residents and their attending physicians have consistently found the effectiveness of clinical workshops in resident training [3, 8, 9].

In our study, almost all residents found the workshops helpful and believed that they increased their skills in neurosurgery. Of course, the timing of participation in different parts of the workshop in the residency curriculum is better suited to the degree of residency. Also, almost all of the attending physicians mentioned the residents' advances in surgical skills. Although none of them used such workshops while studying neurosurgeries, they found it helpful to teach residents. Our analyzing method in this study was subjective, which makes judging the effectiveness of this workshop a bit difficult.

5. Conclusion

Given the wide variations in training hospitals, such as the different number of patients and the specialties available in training centers, such workshops can equalize residents' skills. Although nothing can replace the knowledge and experience gained in the actual operating room, these workshops can alleviate the stress and increase the basic skills of residents that are needed before entering actual operating room conditions. The workshop can improve their learning potential too.

Table 1. The results of residents' questionnaire

Row	Questions	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1	Do you think participating in a craniotomy simulation workshop (coconut) can improve residents' surgical skills in using craniotomy tools? Do you recommend participating in this workshop to other residents?	5	5	1	1	1
2	Do you think participating in a surgical microscope workshop (bell pepper) can improve residents' surgical skills in using a surgical microscope? Do you recommend participating in this workshop to other residents?	9	3	1	0	0
3	Do you think participating in a microsurgical resection workshop (sheep's brain) can improve residents' surgical skills in microsurgical resection? Do you recommend participating in this workshop to other residents?	9	3	1	0	0
4	Do you think participating in a microscopic vascular suture workshop (chicken wing) can improve residents' surgical skills in suturing under a microscope? Do you recommend participating in this workshop to other residents?	11	2	0	0	0
5	Do you think participating in these workshops can increase residents' confidence in the operating room?	2	1	3	2	5
6	Do you think participating in these workshops can increase the speed of residents in performing surgery?	2	1	1	6	3
7	Do you think participating in these workshops can reduce the obvious mistakes of residents during surgery?	0	2	5	2	4
8	Do you think participating in these workshops can be helpful for neurosurgery residents before entering the operating room?	6	4	3	0	0
9	Do you think participating in these workshops can help junior neurosurgery residents understand surgical techniques and their implications?	3	3	4	2	1
10	Do you think that participating in these workshops can be a good alternative to the entry of junior residents into the operating room?	0	0	1	1	11

Table 2. The results of attending physicians questionnaires'

No.	Questions	Totally Agree	Agree	No Idea	Disagree	Totally Disagree
1	Were the residents more skilled in craniotomy after attending these workshops?	0	1	3	0	1
2	Were the residents more skilled at working with microscopes and related techniques after attending these workshops?	4	1	0	0	0
3	Were the residents more confident in the operating room after attending these workshops?	0	1	2	2	0
4	Were the residents faster during surgery after participating in these workshops?	1	1	0	2	1
5	Did residents have fewer obvious errors during surgery after attending these workshops?	0	0	4	1	0
6	Did the residents better understand the surgical approach after participating in these workshops?	1	0	2	1	1

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Ethical Considerations

Compliance with ethical guidelines

Written Informed Consent was obtained from all patients/participants.

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Authors' contributions

Conceptualization and Methodology: Amir Saied Seddighi, Afsoun Seddighi, and Alireza Zali; Data collection: Shiva Jamshidi and Afsoun Seddighi; Data analysis and interpretation: Hesam Rahimi and Amir Saied Seddighi; Writing – original draft: Mostafa Hosseini and Morteza Hosseini; Writing – review & editing: Amir Saied Seddighi and Afsoun Seddighi; Approving the final version of the manuscript: Alireza Zali.

Conflict of interest

The authors declared no conflict of interest.

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