Original Article

Factors Associated with Improved Microsurgical Learning in a Plastic Surgery Training Program

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Background: Microsurgery lab training is one of the best ways to learn and improve microsurgical skills. We explored factors that facilitate positive and efficient development of microsurgical skills during plastic surgery training.

Objective: To identify the factors that are associated with improved microsurgical learning and find out the methods that help to increase efficiency in the microsurgery training program.

Materials and Methods: An open questionnaire examining factors potentially associated with microsurgical learning was administered and six factors were identified. A satisfaction survey about the microsurgery training program was given to students. Using findings from these tools, a reorganization of the microsurgical training program was implemented. Six months later, the survey was administered again and the results were compared with the initial assessment. Student lab participation rates and laboratory costs were measured.

Results: Six months following program reorganization, student satisfaction significantly increased in 5 of 6 parameters; duration for assessment ($p = 0.019$), frequency for assessment ($p \leq 0.001$), clarity of tools and topics ($p = 0.045$), knowledge gained ($p \leq 0.001$), and validity and reliability of the assessor ($p = 0.001$). Overall trainee satisfaction improved from 2.40 to 3.00 ($p = 0.028$). The average microsurgical skill of students increased from 1.77 to 2.35 ($p = 0.001$). Microsurgery lab participation increased from 46 (July to December 2018) to 105 (January to June 2019). The new training protocol reduced the average cost per microsurgery lab session from more than 4,500 baht (145 USD) to 1,468.34 baht (46.4 USD).

Conclusion: Five factors associated with an improved microsurgical learning experience were identified and used to guide program reorganization. Six months later, we measured increased rates of lab participation, improved student satisfaction and reduced program costs.

Keywords: Microsurgery training, Microsurgery lab, Microsurgical skills, Microsurgery, Plastic surgery training

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Microsurgery is a term for techniques performed beyond the limits of human eyesight that require magnification by either surgical loupes or an operating microscope[1]. Microsurgery is a broader term not only limited to blood vessels but also refers to coaptation of nerves and lymphatics[2]. Reconstructive microsurgery utilizes techniques in procedures such as revascularization, replantation, and auto- or allotransplantation to solve problems arising from traumatic injuries, congenital deformities, and tumor ablation[3-5]. At the Division of Plastic Surgery, Department of Surgery, Faculty of Medicine Siriraj Hospital, we perform more than 100 cases of microsurgery every year and teach microsurgical skills to our residents and fellows. The plastic surgery division has 15 students, all of whom learn to practice microsurgery mainly by participation in our microsurgery lab. The microsurgery lab was established in 2008 and more than 40 residents, fellows and international visitors receive training every year.

Microsurgical skill is an important criterion to evaluate competency in plastic surgery students. Students practice dissection, prepare vessels and attempt anastomosis under microscope[6-8]. Video of their work is evaluated by senior staff skilled in microsurgical reconstruction[9]. Third year residents and fellows must pass an evaluation of their silicone tube anastomosis and anastomosis in brachial artery of a chicken wing. Fourth year residents and fellows must pass an evaluation of femoral artery anastomosis in living mice. If they pass these evaluations, our staff will allow 5th year (Chief) residents to assist in reconstructive microsurgical cases in human patients[10-15].

Recognizing the considerable commitment of time and effort this training requires, we aimed to examine our program carefully and explore approaches to improve the microsurgical learning experience.

Materials and Methods

An open questionnaire concerning factors that may

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be associated with the microsurgical learning experience was administered to all[15] trainees. Six factors were identified that influence microsurgical training: 1) Duration for assessment, 2) Frequency for assessment, 3) Clarity of assessment tools and topics, 4) Knowledge gained during assessment, 5) Validity and reliability of the assessor, and 6) Evolution of microsurgical skills after assessment.

A retrospective review about the detail of assessment period coincides with data from microsurgery lab. From this, the new protocol for improving microsurgical learning experience and efficiency included several important changes. First, the duration of the assessment period was extended to be at least 2 hours per session (previously 1 to 2 hours). Second, two assessment periods were required each month (previously 1 time/month). Third, a new microsurgical skills assessment tool was developed and communicated to all students. Fourth, two or more senior were required to evaluate each video to decrease bias and increase the quantity and quality of comments and suggestions. Finally, students were required to submit their anastomotic video after five lab sessions. This was done to reduce costs and to encourage students to optimize their time in the lab.

Before the new protocol was implemented, students were asked to rate their satisfaction with their microsurgical learning program experience and assessment (Very dissatisfied = 0, Somewhat dissatisfied = 1, Indifferent = 2, Somewhat satisfied = 3, Very satisfied = 4). Students, also rated their opinion of the microsurgery training program and microsurgery lab (Hate = 0, Dislike = 1, Indifferent = 2, Like = 3, Love = 4) (Supplemental data 1, https://drive.google.com/open?id=1rECsLcXnXywhrDbiGhH9Ukogq-4SSvBo). Reconstructive microsurgical staff were also asked to score the level of microsurgical competency of the students (Very poor = 0, Poor = 1, Fair = 2, Good = 3, Very good = 4) (Supplement data 2, https://drive.google.com/open?id=1rECsLcXnXywhrDbiGhH9Ukogq-4SSvBo). The questionnaires were administered again six months after implementation of the new training protocol, and the data were compared with the original (pre-intervention) data set. The present study was approved by the Siriraj Institutional Review Board (536/2562(EC4)).

Results

Student satisfaction increased with the new microsurgical learning experience and assessment. The initial average score of all six parameters from the 15 students was 1.91 (of 4), which increased to 3.02 after implementation of the new protocol. Specifically, the "duration for assessment" score increased from 1.73 to 2.87 ($p = 0.019$*), "frequency for assessment" increased from 1.80 to 2.80 ($p \leq 0.001$*), "clarity of assessment tools and topics" increased from 2.60 to 3.13 ($p = 0.045$*), "knowledge gained during assessment" increased from 1.93 to 3.20 ($p \leq 0.001$*), "validity and reliability of the assessor" increased from 1.20 to 2.87 ($p = 0.001$*), and "evolution of microsurgical skills after assessment" increased from 2.73 to 3.13 ($p = 0.301$) (Table 1).

The average score of the student's opinion of the microsurgery training program increased from 2.40 (of 4) to 3.00 and opinion regarding the microsurgery lab increased from 2.53 to 2.87 (Table 2). The average competency score of students as rated by senior surgeons increased from 1.77 (of 4) to 2.35 ($p = 0.001$*) and specifically, for the 5th year resident, scores increased by 0.75, 4th year residents increased by 0.55 and 3rd year residents by 0.45 (Table 3).

Program costs

For the academic year 2017 total program expenses

Table 1. Satisfaction to factors that associated with microsurgical learning experience and assessment (evaluate by residents and fellows)

Topics	Before	After 6 months	*p*-value#
Duration of assessment	1.73 (1.03)	2.87 (0.83)	0.019*
Frequency for assessment	1.27 (0.59)	2.93 (0.96)	<0.001*
Clarity of assessment tools and topics	2.60 (0.51)	3.13 (0.35)	0.045*
Knowledge gained during assessment	1.93 (0.70)	3.20 (0.56)	<0.001*
Validity and reliability of the assessor	1.20 (0.68)	2.87 (0.99)	0.001*
Evolution of microsurgical skills after assessment	2.73 (0.46)	3.13 (0.64)	0.301

Friedman test and post hoc test by Dunn's test, * Statistical significance at $p<0.05$

Table 2. Feeling to Microsurgery training program and microsurgery lab (Evaluated by residents and fellows)

Topics	Before	After 6 months	*p*-value#
Feeling to microsurgery training program	2.40 (0.51)	3.00 (0.54)	0.028*
Feeling to microsurgery lab	2.53 (0.52)	2.87 (0.52)	0.706

Friedman test and post hoc test by Dunn's test, * Statistical significance at $p<0.05$

Table 3. Level of microsurgical skills of plastic surgery residents and fellows (Evaluates by senior staff)

Level of microsurgical skills resident/fellow	Before	After 6 months	*p*-value[#]
All 15 resident/fellow	1.77 (0.42)	2.35 (0.42)	0.001*[@]
Third year resident/fellow	1.80 (0.32)	2.25 (0.35)	
Fourth year resident/fellow	1.75 (0.43)	2.30 (0.27)	
Fifth year resident/fellow	1.75 (0.56)	2.50 (0.61)	

[#] Friedman test and post hoc test by Dunn's test, [@] Wilcoxon signed rank test, * Statistical significance at $p<0.05$

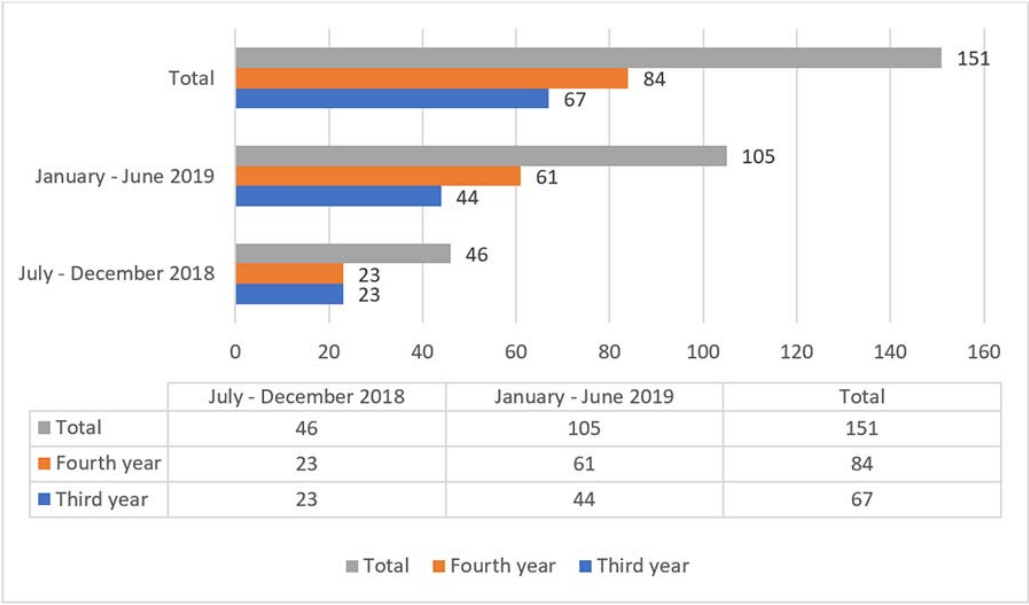

Figure 1. Microsurgery lab attendance by plastic surgery residents and fellows in academic year of 2018.

were 250,000 Thai baht ($8,065 USD) and students participated in the lab 46 times (average cost per visit 5,434.78 baht or $175.32 USD). In the first semester of the 2018 academic year 2018 (before the new protocol), the total microsurgical lab costs were 208,524 baht ($6,726.58 USD), including 46 lab sessions. The average cost per lab session was 4,533.13 baht ($146.23 USD).

During the six months of new protocol implementation (January to June 2019), the total microsurgical lab cost was 154,176 baht ($4,973.42 USD), and students visited the lab 105 times. The average cost per visit was 1,468.34 baht ($46.40 USD), a three-fold reduction.

Discussion

Microsurgery requires excellent hand-eye coordination, delicate hand skills, and years of training. We endeavor to train residents and fellows in microsurgery to achieve high-level skills and confidence in their ability to succeed after completing the plastic surgery training program. However, due to the time requirements and the intensity of this training some students have had an unfavorable opinion of the program. Therefore, we aimed to improve the learning experience and expertise of our students by using data to inform program changes.

We found that student satisfaction regarding the microsurgical learning experience was dependent on five major factors. In addition, we also significantly improved the attitude of students by implementing an improved training protocol. For microsurgery lab, even though the result from post-intervention with new protocol didn't improve, in my opinion the reason might be from being quite high in the pre-test score (2.53). It means that even though the trainees had many complaints and negative comments about microsurgery lab and deeply so, they never truly hated to train microsurgical skills in the lab.

We observed a significant improvement in the microsurgical skill of residents and fellows. This could be partly explained by the positive change in student attitude and increased microsurgical lab participation (Figure 1).

The new training protocol resulted in a considerable reduction in per visit microsurgical laboratory costs. The

new protocol also made it easier to observe and support the technical skill progression of each student. Although some diligent students may have felt limited by the new protocol, overall it was a success.

Conclusion

Achieving an optimum training protocol is challenging. Many variables, including the learning style of the students, influence both the learning environment and the outcome. By conducting a thorough program assessment, we identified five primary factors that significantly impact the microsurgical learning experience. We then applied our findings to reform the design and implementation of a new training protocol that yielded superior results. Our experience may provide valuable insight for other programs that wish to improve the student experience with the larger goal of advancing the reconstructive microsurgical field.

What is already known on this topic?

Microsurgery is one of the most important courses during resident and fellowship training in plastic surgery program curriculum. Due to it need quite long duration to practice and very steep learning curve, many students feel discomfort and bored with this subject and finally declined to learn and perform this kind of surgery.

The researchers in many institutes try to improve microsurgery training programs in many ways such as changing in details of microsurgery course (such as assessment methods, assessment tools, and training models in microsurgery lab), using new technology to improve the learner satisfaction (such as computer simulation, video record for assessment), but still have not found the best resolution to yield the best microsurgical learning experience for plastic surgery students.

What this study adds?

This might be the first report about the factors that associated with learning experience in microsurgical training program. The results that I have found in this topic not only affected to satisfaction of the trainees, but also microsurgical skills of the trainees and the training program costs.

Thus, our experience may provide valuable insight for other programs that wish to improve the student experience with the larger goal of advancing the reconstructive microsurgical field.

Potential conflicts of interest

The author declare no conflicts of interest.

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ปัจจัยที่สัมพันธ์ต่อการพัฒนาการเรียนรู้ในรายวิชาจุลศัลยศาสตร์ขณะศึกษาต่อแพทย์เฉพาะทางสาขาศัลยศาสตร์ตกแต่ง

ณัฐวุฒิ อัครานุชาต

ภูมิหลัง: การฝึกปฏิบัติในห้องปฏิบัติการจุลศัลยศาสตร์ นับเป็นหนึ่งในวิธีที่ดีที่สุดในการฝึกฝนและพัฒนาฝีมือ (skills) ในการผ่าตัดทางจุลศัลยศาสตร์ ในงานวิจัยนี้ผู้นิพนธ์ได้พยายามศึกษาถึงปัจจัยที่ส่งผลในเชิงบวกและมีส่วนช่วยเพิ่มประสิทธิภาพของการพัฒนาฝีมือ (skills) ในการผ่าตัดทางจุลศัลยศาสตร์ของแพทย์ประจำบ้านและแพทย์ประจำบ้านต่อยอดในช่วงระยะเวลาของการฝึกอบรมวิชาศัลยศาสตร์ตกแต่ง

วัตถุประสงค์: เพื่อศึกษาถึงปัจจัยที่สัมพันธ์ต่อการพัฒนาการเรียนรู้ในรายวิชาจุลศัลยศาสตร์ และหาแนวทางในการปรับปรุงรูปแบบการเรียนการสอนในรายวิชาจุลศัลยศาสตร์ให้มีประสิทธิภาพมากยิ่งขึ้น

วัสดุและวิธีการ: ในขั้นแรกแบบสอบถามปลายเปิดได้ถูกส่งให้ผู้ฝึกอบรม เพื่อสอบถามถึงปัจจัยที่เกี่ยวข้องและส่งผลต่อประสบการณ์การเรียนรู้ของผู้เข้ารับการฝึกอบรมในรายวิชาศัลยศาสตร์ตกแต่ง ซึ่งสามารถระบุมาได้ทั้งสิ้น 6 ปัจจัย จากนั้นให้ผู้เข้ารับการฝึกอบรมทำการประเมินแบบสอบถามความพึงพอใจเกี่ยวกับการเรียนการสอนในรายวิชาจุลศัลยศาสตร์ และการฝึกปฏิบัติในห้องปฏิบัติการจุลศัลยศาสตร์ รวมถึงให้ผู้ฝึกสอนได้ทำการประเมินระดับฝีมือ (skills) ของผู้เข้ารับการฝึกอบรม หลังจากรวบรวมข้อมูลที่ได้ผู้ประพันธ์ได้ทำการปรับปรุง และพัฒนารูปแบบการเรียนการสอนขึ้นใหม่โดยอ้างอิงจากปัจจัยที่ปรากฏจากแบบสอบถาม และเมื่อครบ 6 เดือนภายหลังจากปรับปรุงการเรียนการสอน ผู้เรียนและผู้ฝึกสอนจะทำการประเมินแบบสอบถามแบบเดียวกับที่เคยได้ทำไปแล้วอีกครั้ง และนำผลลัพธ์ที่ได้มาเปรียบเทียบกัน ซึ่งในขณะที่ทำการวิจัยนี้ทางผู้นิพนธ์ก็ได้ทำการเก็บรวบรวมข้อมูลของการเข้าฝึกปฏิบัติในห้องปฏิบัติการจุลศัลยศาสตร์ และค่าใช้จ่ายที่เกิดขึ้นในห้องปฏิบัติการทั้งหมดร่วมด้วย

ผลการศึกษา: 6 เดือน ภายหลังจากการปรับปรุงและพัฒนารูปแบบการเรียนการสอน พบว่าระดับความพึงพอใจของผู้เข้ารับการฝึกอบรมเพิ่มสูงขึ้นอย่างมีนัยสำคัญใน 5 จาก 6 ปัจจัย ได้แก่ ระยะเวลาของการตรวจประเมินผล ($p = 0.019$), ความถี่ของการตรวจประเมินผล ($p \leq 0.001$), ความชัดเจนของตัวชี้วัดและหัวข้อของการตรวจประเมินผล ($p = 0.045$), ความรู้ที่ได้ขณะเข้ารับตรวจประเมิน ($p \leq 0.001$), และความถูกต้องและน่าเชื่อถือของผู้ทำการประเมิน ($p = 0.001$) ผลรวมระดับความพึงพอใจของผู้เข้ารับการฝึกอบรมที่มีต่อรายวิชาจุลศัลยศาสตร์เพิ่มสูงขึ้นอย่างมีนัยสำคัญ 2.40 ถึง 3.00 ($p = 0.028$) ในขณะเดียวกันระดับฝีมือ (skills) ในการผ่าตัดทางจุลศัลยศาสตร์ของผู้เข้ารับการฝึกอบรมก็เพิ่มสูงขึ้นอย่างมีนัยสำคัญ 1.77 ถึง 2.35 ($p = 0.001$)

จำนวนครั้งในการเข้าฝึกปฏิบัติในห้องปฏิบัติการจุลศัลยศาสตร์เพิ่มขึ้นอย่างชัดเจนจาก 46 ครั้ง (เดือนกรกฎาคม ถึง เดือนธันวาคม พ.ศ. 2561) เป็น 105 ครั้ง (เดือนมกราคม ถึง เดือนมิถุนายน พ.ศ. 2562) นอกจากนี้รูปแบบการเรียนการสอนแบบใหม่ยังช่วยลดค่าใช้จ่าย ที่เกิดขึ้นจากการฝึกปฏิบัติในห้องปฏิบัติการในแต่ละครั้งลงจากเดิมที่มากกว่า 4,500 (145 USD) บาทต่อครั้ง เหลือเพียง 1,468.3 (46.4 USD) บาทต่อครั้งของการเข้าฝึกปฏิบัติ

สรุป: จากงานวิจัยนี้เราได้ทราบถึง 5 ปัจจัยที่เกี่ยวข้อง และส่งผลในเชิงบวกต่อประสบการณ์การเรียนรู้ในรายวิชาจุลศัลยศาสตร์ ซึ่งส่งผลดีทั้งต่อการเพิ่มขึ้นของจำนวนครั้งในการเข้าฝึกปฏิบัติในห้องปฏิบัติการจุลศัลยศาสตร์ ระดับความพึงพอใจของผู้เข้ารับการฝึกอบรม และช่วยลดค่าใช้จ่ายที่เกิดขึ้นจากการฝึกอบรมลง