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ORIGINAL RESEARCH

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A randomized study on the value of self-directed versus traditional mentor-led microsurgical training

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Abstract

Objective: Analyze efficacy of self-directed resident microvascular training versus a mentor-led course.

Study Design: Randomized, single-blinded cohort study.

Setting: Academic tertiary care center.

Methods: Sixteen resident and fellow participants were randomized into two groups stratified by training year. Group A completed a self-directed microvascular course with instructional videos and self-directed lab sessions. Group B completed a traditional mentor-led microvascular course. Both groups spent equal time in the lab. Video recorded pre and post-course microsurgical skill assessments were performed to assess the efficacy of the training. Two microsurgeons, blinded to participant identity, evaluated the recordings and inspected each microvascular anastomosis (MVA). Videos were scored using an objective-structured assessment of technical skills (OSATS), a global rating scale (GRS), and quality of anastomosis scoring (QoA).

Results: The pre-course assessment identified that the groups were well matched with only “Economy of Motion” on the GRS favoring the mentor led group ($p = .02$). This difference remained significant on the post assessment ($p = .02$) Both groups significantly improved in OSATS and GRS scoring ($p < .05$). There was no significant difference in OSATS improvement between the two groups ($p = .36$) or improvement in MVA quality between groups ($p > .99$). Time to completion of MVA significantly improved overall by a mean of 8 min and 9 s ($p = .005$) with no significant difference between post training times to complete ($p = .63$).

Conclusion: Different microsurgical training models have previously been validated as effective methods for improved MVA performance. Our findings indicate that a self-directed microsurgical training model is an effective alternative to a traditional mentor driven models.

Level of Evidence: Level 2.

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KEYWORDS
low-fidelity model, microsurgical training, microvascular anastomosis, resident training, self-directed

1 | INTRODUCTION

Microsurgery is a demanding fine motor technical skill. Acquisition of microsurgical skills are dependent on intensive training and exposure over time.[1] The challenge of increasing microsurgery exposure during residency training is complicated by the need for specialized equipment and lab, supervision and guidance of attendings, and single use item costs. Thus, much effort has been invested to determine an approach to efficiently develop surgeons with microsurgical skills. It has been well established that a low-fidelity microsurgical simulation model (i.e., non-living models) allows for similar development compared to high fidelity models when training developing surgeons.[2–4] Of the multitude of non-living models, the value of utilizing chicken thigh vessels for improving resident microsurgical skills has previously been established.[5–7] This model has greatly reduced the resources required for training events.[8]

Recent literature has evaluated the efficacy of remote and independent learning and found it to be an effective tool for teaching microsurgery.[8,9] It has been found that self-directed microsurgery programs paired with regular practice does produce an increase in

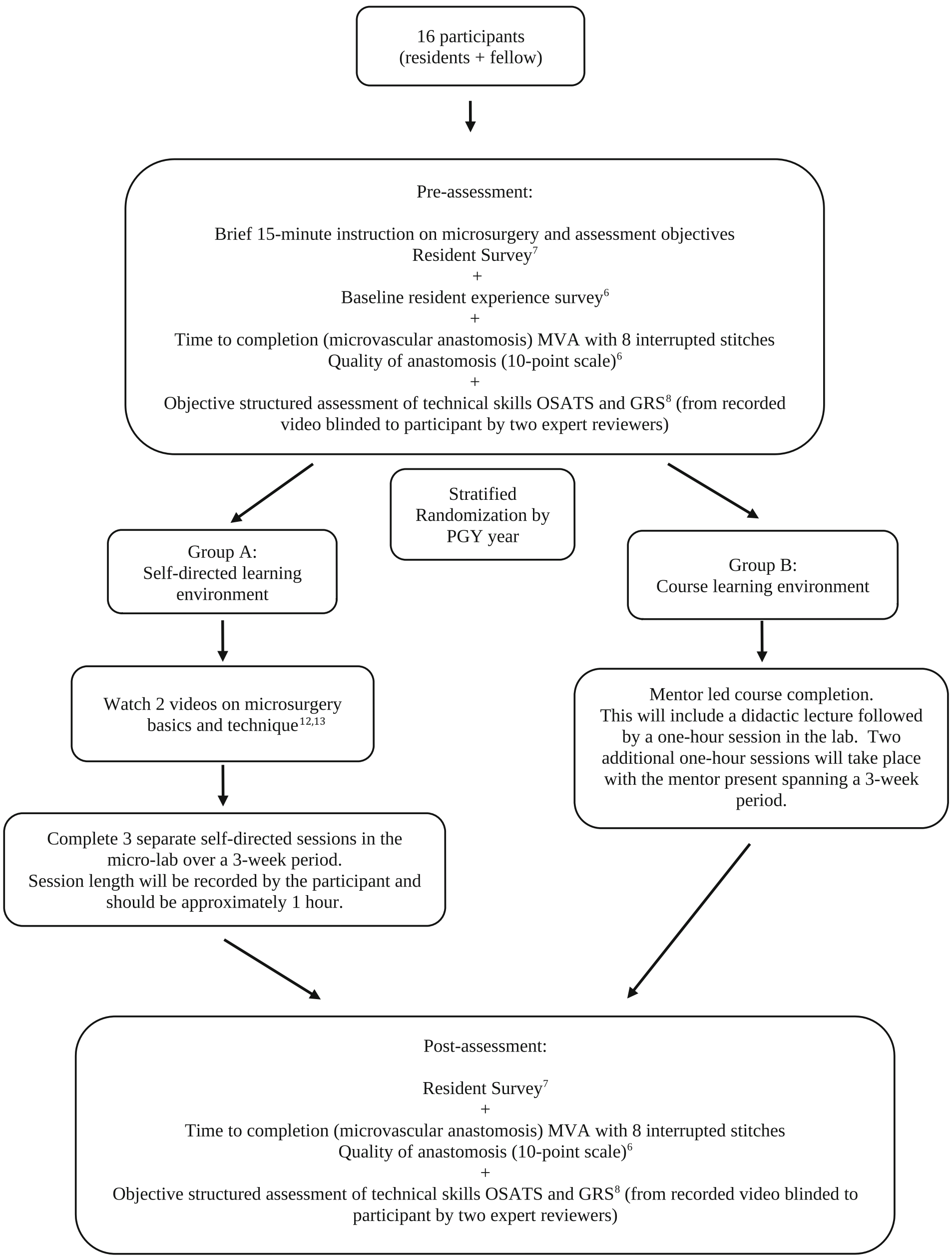

FIGURE 1 Study methodology

knowledge and skills.[9] Implementation of a self-directed course is also aided by the finding that trainees generally have the awareness to evaluate themselves during the acquisition of microsurgery skills.[10]

The prospect of pairing a low fidelity training model with the autonomy of a self-directed course may allow for an increased number of training events resulting in greater skills development. Additionally, in the COVID-19 era this potential training model would allow for more flexible and decentralized training that keeps with social distancing guidelines.

Thus, this study sought to evaluate the efficacy of a self-directed resident microvascular training compared to a traditional mentor-led course.

2 | MATERIALS AND METHODS

2.1 | Pre-training assessment

Following approval by the University of Arkansas for Medical Sciences Institutional Review Board (IRB# 261494), 16 participants (15 residents & 1 fellow) were approached to participate in a microvascular curriculum and comparative study. All 16 participants reviewed the objectives of the study and completed a 15-min instructional video on microvascular anastomosis (MVA) (Figure 1). Each participant completed a baseline resident experience survey answering the number of months they have rotated on a microsurgical service and number of microsurgical cases they had performed. A pre-assessment survey was used to assess their comfort level using the operative microscope, handling microsurgical instruments, and performing an MVA.

All participants then performed an MVA with eight interrupted stitches on a chicken thigh vessel while being video recorded. Time required to complete the MVA was collected. Two fellowship-trained microvascular surgeons, who were blinded to the participants, independently graded each anastomosis under the operative microscope utilizing a Quality of Anastomosis (QoA) (Appendix 1, Data S1) scoring system.[8] The video recordings were then independently reviewed by the two expert reviewers to assess baseline technical performance using a microvascular Objective Structured Assessment of Technical Skills (OSATS) scoring system. This included both a Task Specific Score (TSS) (Appendix 2, Data S1) and Global Rating Scale (GRS) (Appendix 3, Data S1) which has been previously validated to differentiate between levels of microvascular ability using the chicken thigh vessel model.[11] Video recordings did not include any identifiable images of the participants to ensure that the reviewers remained blinded to the participants.

2.2 | Self-directed and mentor-led training

Participants underwent stratified randomization in which the PGY level defined the strata. Simple randomization was applied to the strata to determine the method of learning. Group A completed a self-directed learning course consisting of two training videos on microsurgery basics and technique.[12,13] Group A then completed three self-directed one-hour sessions in the microvascular lab. In contrast, Group B completed a traditional didactic presentation by a mentor. Group B then completed three 1-h sessions in the microvascular lab with a mentor present. All sessions for both groups were completed over a one-month period.

2.3 | Post-training assessment

Each participant completed a post-assessment survey assessing their comfort level with using the operative microscope, handling microsurgical instruments, and performing a MVA. All participants then performed a MVA with eight interrupted stitches on a chicken thigh vessel while being video recorded. Participants were again graded by the same two expert reviewers utilizing the QoA, OSATS-TSS, and GRS scoring systems, as described above. Time to complete the MVA was also documented.

2.4 | Statistical analysis

To determine statistically significant data the pre and post assessments were analyzed using a T-test and the reviewer evaluations were analyzed using ANOVA.

TABLE 1 Baseline resident experience

Number of residents	
PGY-1	3
PGY-2	3
PGY-3	3
PGY-4	3
PGY-5	3
PGY-6	1
Overall	16
Months of microsurgery[a]	
PGY-1	1.2 (1.0)
PGY-2	3.3 (1.5)
PGY-3	5.0 (1.7)
PGY-4	7.3 (2.1)
PGY-5	7.7 (2.1)
PGY-6	15 (0)
Overall	5.5 (3.8)
Microsurgical cases performed[a]	
PGY-1	0 (0)
PGY-2	7.3 (4.9)
PGY-3	7.7 (4.0)
PGY-4	32.3 (15.4)
PGY-5	23.3 (15.3)
PGY-6	60 (0)
Overall	17.0 (18.4)

[a]Values given as the mean (SD).

TABLE 2 Improvement within groups

Assessment	Comparison between groups: Pre-training baseline: Self-directed (mean min:s) (SD)	Mentor-led (mean min:s) (SD)	*p*-value	Post-training assessment: Self-directed (mean min:s) (SD)	Mentor-led (mean min:s) (SD)	*p*-value	Comparison within groups: Self-directed pre vs. post *p*-value	Mentor-led pre vs. post *p*-value
Time to complete anastomosis	26:49 (14:38)	21:02 (7:17)	.33	16:27 (5:50)	15:06 (5:03)	.63	.06	**.008**
QoA[a]								
Average apposition of tissue edges	6.00 (1.39)	6.38 (1.55)	.62	6.25 (1.83)	7.44 (1.57)	.19	.76	.061
Average backwall	8.88 (3.18)	7.88 (3.93)	.59	8.88 (3.18)	7.75 (4.17)	.55	>.99	.96
Average suture configuration and separation	5.75 (1.69)	6.06 (1.50)	.70	5.86 (1.81)	6.88 (1.41)	.24	.88	.18
Average equidistant bites on vessel edges	6.00 (1.54)	6.38 (1.81)	.66	7.06 (1.24)	7.44 (1.45)	.59	.11	.18
Average overall appearance of the final anastomosis	5.56 (1.90)	5.88 (2.17)	.76	6.00 (2.31)	6.31 (2.55)	.80	.67	.73
OSATS[b]								
OSATS-TSS	8.31 (1.62)	9.50 (1.93)	.20	11.69 (1.10)	12.19 (1.22)	.40	**<.001**	**.001**
GRS[c]								
Economy of motion	1.81 (0.53)	2.75 (0.80)	.15	3.13 (0.44)	3.88 (0.64)	.17	**.001**	**<.001**
Instrument handling	2.19 (0.46)	2.75 (0.60)	.53	3.38 (0.58)	3.50 (0.76)	.72	**<.001**	**.001**
Respect of tissue	2.63 (0.64)	2.75 (1.10)	.79	3.25 (0.85)	3.63 (0.79)	.38	**.028**	**.03**
Flow of operation	2.19 (0.53)	2.75 (0.71)	.09	3.50 (0.53)	3.75 (0.65)	.42	**.001**	**<.001**
Overall result	2.25 (0.53)	2.75 (0.65)	.12	3.44 (0.42)	3.75 (0.65)	.27	**<.001**	**<.001**

Abbreviations: GRS, Global Rating Scale; OSATS, Objective Structured Assessment of Technical Skills; QoA, Quality of Anastomosis; TSS, Task Specific Score.
Note: Bold values significes $p < 0.05$.
[a]Values reported as averages of two blinded reviewers grading on a 1–10 point scale ± the standard deviation.
[b]Values reported as averages of two blinded reviewers grading on a 14-point maximum score ± the standard deviation.
[c]Values reported as averages of two blinded reviewers grading on a 1–5 point scale ± the standard deviation.

3 | RESULTS

3.1 | Demographic information

Fifteen otolaryngology residents and one fellow were enrolled and successfully completed the curriculum. Those enrolled ranged between PGY-1 to PGY-6 with an increasing amount of microsurgery exposure and experience associated with increasing PGY level (Table 1).

3.2 | Pre-training baseline

There was no statistical difference between the two groups in the QoA, OSATS-TSS, or GRS scores for the pre-training MVA (Table 2). The mentor-led group completed the pre-training MVA faster than the self-directed group (26.5 vs. 21.0 min; $p = .33$).

3.3 | Self-directed training

When compared to their pre-training baseline, the self-directed group improved significantly in OSATS-TSS ($p < .001$) and all categories of the GRS (Table 2). The mean time to complete the MVA improved by 10 min and 22 s, but was not statistically significant ($p = .06$). There was no statistically significant difference between the post-training and pre-training QoA scores for the self-directed group.

3.4 | Mentor-led training

When compared to their pre-training baseline, the mentor-led group improved significantly in OSATS-TSS ($p = .001$) and all categories of the GRS (Table 2). The mean time to complete the MVA improved by 5 min and 56 s ($p = .008$). There was no statistically

TABLE 3 Improvement between groups

Assessment	Improvement in score: Self-directed Delta (mean min:s) (SD)	Self-directed *p*-value	Mentor-led Delta (mean min:s) (SD)	Mentor-led *p*-value	Comparison self-directed vs. mentor-led improvement *p*-value
Time to complete anastomosis	10:22 (13:17)	*.063*	5:56 (4:33)	***.008***	*.39*
QoA[a]					
Average apposition of tissue edges	0.25 (2.19)	*.76*	1.06 (1.35)	*.06*	*.39*
Average backwall	0.00 (0.00)	*>.99*	0.13 (6.62)	*.96*	*.97*
Average suture configuration and separation	0.13 (2.17)	*.88*	0.81 (1.56)	*.18*	*.48*
Average equidistant bites on vessel edges	1.06 (1.61)	*.11*	1.06 (2.00)	*.18*	*>.99*
Average overall appearance of the final anastomosis	0.44 (2.77)	*.67*	0.44 (3.48)	*.73*	*>.99*
OSATS[b]					
OSATS-TSS	3.38 (1.55)	***<.001***	2.69 (1.33)	***.001***	*.36*
GRS[c]					
Economy of motion	1.31 (0.65)	***.001***	1.13 (0.44)	***<.001***	*.51*
Instrument handling	1.19 (0.46)	***<.001***	0.75 (0.38)	***.001***	*.06*
Respect of tissue	0.63 (0.64)	***.03***	0.86 (0.92)	***.03***	*.54*
Flow of operation	1.31 (0.70)	***.001***	1.00 (0.27)	***<.001***	*.27*
Overall result	1.19 (0.53)	***<.001***	1.00 (0.27)	***<.001***	*.39*

Abbreviations: GRS, Global Rating Scale; OSATS, Objective Structured Assessment of Technical Skills; QoA, Quality of Anastomosis; TSS, Task Specific Score.
Note: Bold values significes $p < 0.05$.
[a]Values reported as averages of two blinded reviewers grading on a 1–10 point scale ± the standard deviation.
[b]Values reported as averages of two blinded reviewers grading on a 14-point maximum score ± the standard deviation.
[c]Values reported as averages of two blinded reviewers grading on a 1–5 point scale ± the standard deviation.

TABLE 4 Comfort level survey[a]

What is your comfort level...	Self-directed Pre-training	Self-directed Post-training	Self-directed *p*-value	Mentor-led Pre-training	Mentor-led Post-training	Mentor-led *p*-value
Using an operating microscope?[a]	6.14 (2.12)	7.43 (1.99)	**.02**	6.00 (2.83)	8.29 (0.95)	**.03**
Using microsurgical instruments?[a]	4.86 (2.41)	6.57 (1.62)	**.05**	4.14 (2.27)	8.29 (1.25)	**.001**
Completing a microvascular anastomosis?[a]	1.71 (0.95)	5.14 (1.86)	**<.001**	2.89 (2.41)	7.86 (1.57)	**.001**

Note: Bold values significes $p < 0.05$.
[a]Values self-reported by trainees on a 1–10 point scale (SD).

significant difference between the post-training and pre-training QoA scores for the mentor-led group.

3.5 | Comparing improvement in self-directed versus mentor-led training

When evaluating the development of microsurgical skills there was no significant difference between the self-directed group and the mentor-led group in post-training OSATS-TSS ($p = .36$) or any of the GRS categories (Table 3). Time to complete the MVA was similar between both groups (16.5 vs. 15.1 min; $p = .63$) and there was no difference between any of the QoA domains.

3.6 | Participant survey

Comparison of pre and post-training participant surveys revealed that both training groups improved in comfort level when operating a microscope, using microsurgical instruments, and completing a MVA (Table 4).

4 | DISCUSSION

Microsurgical training is an integral component to a wide array of surgical specialties. But acquiring microsurgical skills represents an academic and logistical challenge for program directors. Our study found no statistically significant difference in trainee development when comparing self-directed training with traditional mentor-led courses in the context of low-fidelity microsurgical training.

This exciting finding prompts additional questions for programs considering implementing a self-directed microsurgical training model. One of which is the potential impact of reduced mentorship engagement of senior surgeons during self-directed microsurgical training. While the potential impact of this reduced mentorship warrants further investigation, it must be noted that the flexibility of incorporating a self-directed model provides the opportunity for a hybrid model to be utilized. Allowing each program to determine the optimal balance of mentor involvement with the repetition required for a trainee to advance from a simulated microsurgical environment.

Another question this study prompts is, what level of microsurgical skill can be reasonably acquired by a trainee before the mentorship of a senior surgeon must be incorporated? When considering the upper limits of a self-directed microsurgical training program the findings of this study would suggest that the microsurgical trainee would likely play a central role. The resident survey from this study is consistent with previous findings, that self-assessment of microsurgical development can have good to excellent agreement with preceptor-assessment scores suggesting good interrater reliability.[10] Indicating that with clearly communicated goals a microsurgical trainee could training until ready for a skills checkoff from a senior surgeon. The maximum application of self-directed microsurgical training is an exciting new question to be asked and is an opportunity for further investigation.

While this study adds to the literature by analyzing the utility of self-directed versus mentor-lead microsurgical training, it is not without limitations. Our explanation for the lack of improvement in the QoA scores is due to a lack of blinding of participants that time was a recorded factor. Consequently, total time to completion was significantly lower after training while participants maintained the same anastomosis quality. Future studies would be improved by ensuring complete blinding of time as a recorded factor. This study was also limited due to the inherent limited number of residents and our program being three residents per resident class. Considering the implications of this study, a follow-up multisite study is warranted to confirm our findings and further explore the potential of incorporating a self-directed microsurgical training model.

5 | CONCLUSION

This study determined that utilizing a low fidelity self-directed resident microsurgical training is an effective alternative to a traditional mentor driven course. Programs that include microsurgical training that are seeking increased flexibility and efficient allocation of resources should consider incorporating a self-directed component to their resident microsurgical training model.

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CONFLICT OF INTEREST
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REFERENCES

1. Kania K, Chang DK, Abu-Ghname A, et al. Microsurgery training in plastic surgery. *Plast Reconstr Surg Glob Open*. 2020;8(7):e2898.
2. Ghanem AM, Hachach-Haram N, Leung CC, Myers SR. A systematic review of evidence for education and training interventions in microsurgery. *Arch Plast Surg*. 2013;40(4):312-319.
3. Chan WY, Matteucci P, Southern SJ. Validation of microsurgical models in microsurgery training and competence: a review. *Microsurgery*. 2007;27(5):494-499.
4. Grober ED, Hamstra SJ, Wanzel KR, et al. The educational impact of bench model fidelity on the acquisition of technical skill: the use of clinically relevant outcome measures. *Ann Surg*. 2004;240(2):374-381. doi:10.1097/01.sla.0000133346.07434.30
5. Ilie VG, Ilie VI, Dobreanu C, Ghetu N, Luchian S, Pieptu D. Training of microsurgical skills on nonliving models. *Microsurgery*. 2008;28(7):571-577.
6. Creighton FX, Feng AL, Goyal N, Emerick K, Deschler D. Chicken thigh microvascular training model improves resident surgical skills. *Laryngoscope Invest Otolaryngol*. 2017;2(6):471-474.
7. Volovici V, Dammers R, Lawton MT, et al. The flower petal training system in microsurgery: validation of a training model using a randomized controlled trial. *Ann Plast Surg*. 2019;83(6):697-701.
8. Luther G, Blazar P, Dyer G. Achieving microsurgical competency in orthopaedic residents utilizing a self-directed microvascular training curriculum. *J Bone Joint Surg Am*. 2019;101(3):e10.
9. Satterwhite T, Son J, Carey J, et al. Microsurgery education in residency training: validating an online curriculum. *Ann Plast Surg*. 2012;68(4):410-414.
10. Grant AL, Temple-Oberle C. Utility of a validated rating scale for self-assessment in microsurgical training. *J Surg Educ*. 2017;74(2):360-364.
11. Nimmons GL, Chang KE, Funk GF, Shonka DC, Pagedar NA. Validation of a task-specific scoring system for a microvascular surgery simulation model. *Laryngoscope*. 2012;122(10):2164-2168.
12. Preconditions of Microsurgical Skill. www.youtube.com. Accessed October 22, 2021. https://www.youtube.com/watch?v=OXPzLAEdKhQ
13. Basic Microsuture Technique. www.youtube.com. Accessed October 22, 2021. https://www.youtube.com/watch?v=3tDYU3f1XfY

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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