

Introduction

- Cerebrovascular surgical training faces a daunting challenge: training neurosurgeons to competently perform complex open cerebrovascular procedures in the era of neuroendovascular interventions.
- As endovascular indications widen, and the endovascular workforce shifts to include more non-surgical specialists, the number of open vascular cases continues to decrease.
- The result is a formidable paradox— resident exposure to surgical cases decreasing while the complexity of the available cases is increasing; creating a dilemma in which residents must learn open cerebrovascular surgery by participating in complex cases while lacking the experience of basics of aneurysm surgery, steepening the learning curve dramatically.
- The objective of this study is to quantify chief residents’ experience and comfort level with clipping of anterior circulation aneurysms to identify a threshold amount of aneurysm experience necessary to produce a comfortable surgeon.

Methods

- An anonymized seven-question cross-sectional survey was created and circulated to all neurosurgery chief residents of ACGME accredited programs within the US for the 2023-2024 academic year.
- The survey assessed program size, clippings/year at their program, number of cases observed/assisted on during their residency, number of cases microdissected/clipped during their residency and their perceived comfort level performing these cases.
- A binary logistic regression was used to perform a machine learning model capable of predicting comfort level based on experience.

Results

- Survey results are summarized in **Table 1**.
- Survey response rate 37.5%, capturing 80 out of 213 chief residents.
 - Mean program size was 2.26 ± 0.87 residents/year.
 - Mean number of cases/year was 30.1 ± 32.1 (Range: 1-180).
 - Mean cases observed/assisted was 23.8 ± 21.5.
 - Mean number of cases microdissected/clipped was 8.5 ± 12.2 (Range: 0-55).
 - Mean comfort level was 5.1 ± 2.6.
 - 75% of chief residents had microdissected/clipped <10 aneurysms.

TABLE 1.
Summary of survey results

	Mean (SD)	Median (IQR)	Range (Min-Max)
Clippings/year	30.1 (32.1)	20 (10-40)	1 - 180
Assisted	23.8 (21.5)	15.5 (10-35)	2 - 100
Clipped	8.5 (12.2)	3 (1-11)	0 - 55
Comfort level	5.1 (2.61)	5 (3-7)	1 - 10

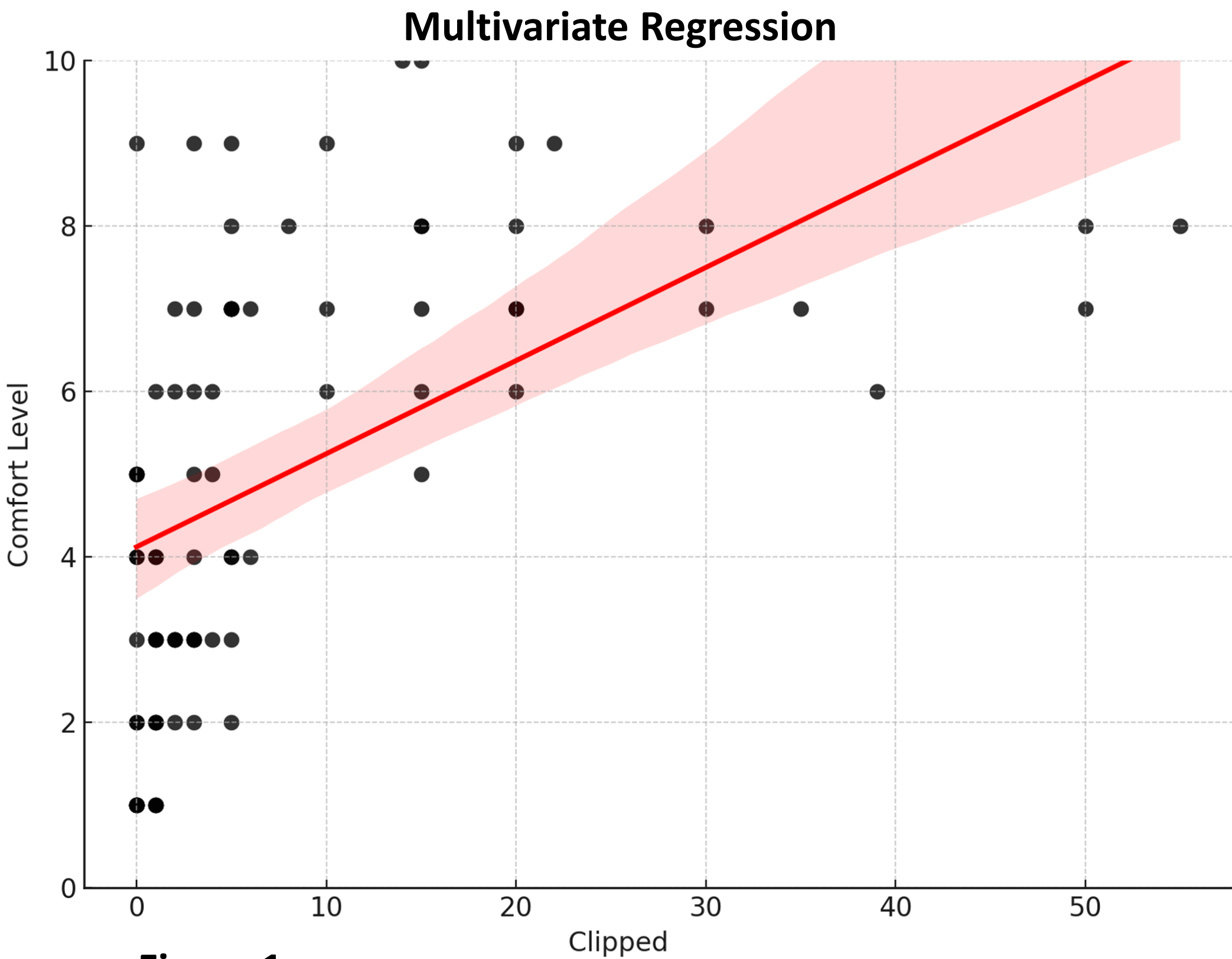


Figure 1.

Multivariate regression analysis showed number of cases clipped as the most important factor influencing comfort level ($p < 0.001$) (**Figure 1**).

Results Continued

- The machine learning model’s performance is shown in **Table 2** and the decision boundary is shown in **Figure 2**.
- The number of cases clipped necessary to reach 50% probability of being comfortable, assuming a median 15.5 cases assisted, was 6.2 aneurysms.
 - The number of cases clipped necessary to reach 99.9% probability of being comfortable, was 28.6 aneurysms.
 - After clipping 6.2 aneurysms, each additional case clipped increased the chance of being comfortable by 7.71%.
 - In contrast, each additional case assisted increased that chance by 0.55%.
 - The impact of aneurysm clipping versus assistance on comfort level was 14:1.

TABLE 2.
Post-optimization binary logistic regression model metrics

Overall Accuracy	83.80%	
Confusion Matrix	Predicted Cases	
	Not comfortable	Comfortable
Not comfortable	39	3
Comfortable	10	28
Precision	79.60%	90.30%
Recall	92.90%	73.70%
F1-Score	85.70%	81.20%
Note: Optimization included Lasso regularization and hyperparameter tuning (C= 10)		

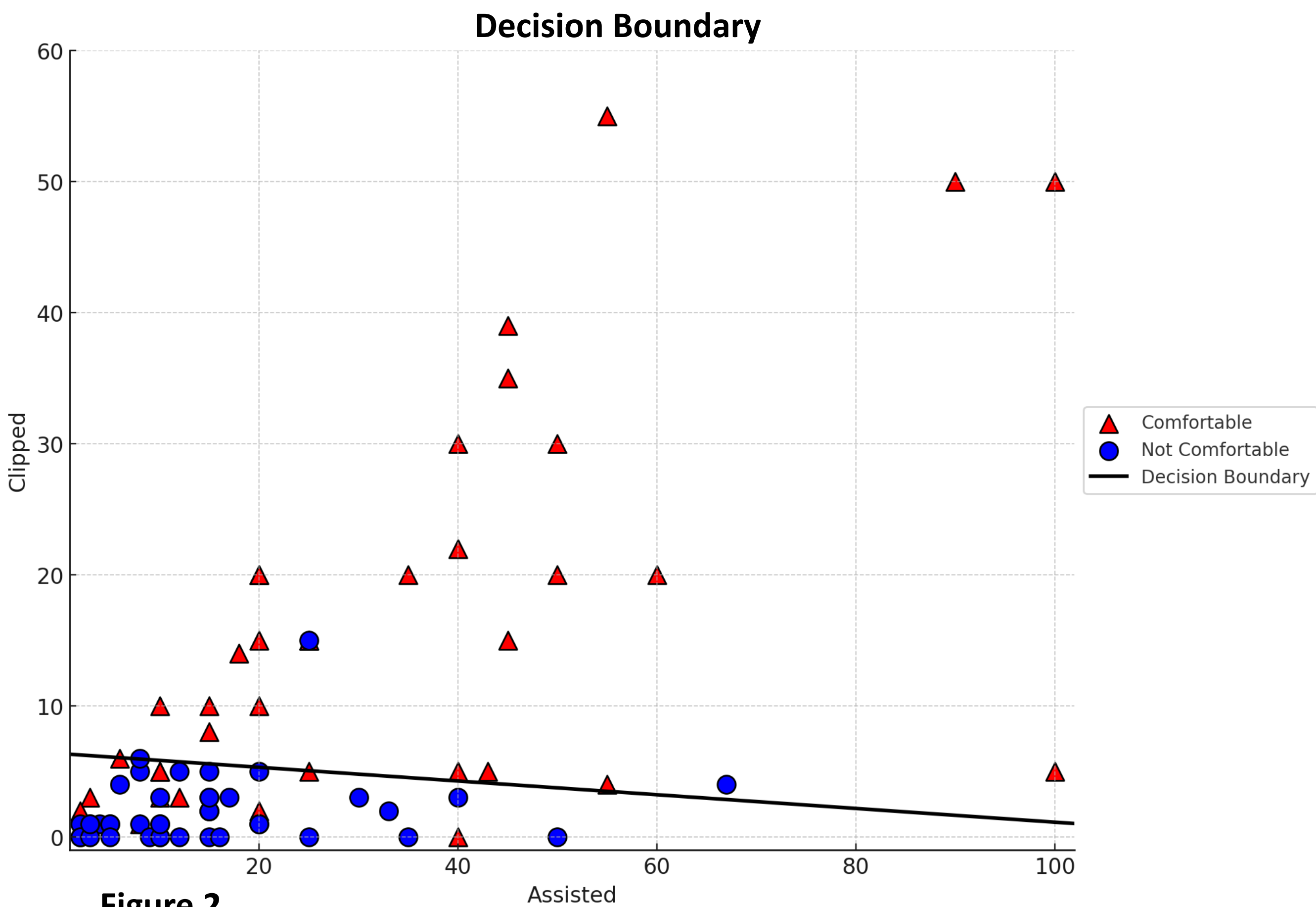


Figure 2.

Conclusions

- Our findings provide unique insights into residents’ preparedness to clip anterior circulation aneurysms. This is extremely relevant for contemporary neurosurgery education.
 - There has been a dramatic decrease in the amount of anterior circulation aneurysm clippings, underscored by the wide range of cases per year per institution.
 - Most chief residents have insufficient experience to be comfortable with these cases.
 - Approximately 29 cases clipped are needed to produce a comfortable surgeon.
 - Hands-on experience has 14-fold impact over passive participation.
- This study represents the first instance of “appraisal” of the value of a surgical training experience in the neurosurgery field.
- By identifying a threshold number of cases necessary to achieve comfort, we have potentially provided an objective benchmark to guide decision-making regarding competency in the surgical training for clipping of anterior circulation aneurysms.

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References

- Andaluz N, Zuccarello M. Recent trends in the treatment of cerebral aneurysms: analysis of a nationwide inpatient database. *J Neurosurg.* Jun 2008;108(6):1163-9. doi:10.3171/jns.2008.108.6.1163
- Deshmukh AS, Priola SM, Katsanos AH, et al. The Management of Intracranial Aneurysms: Current Trends and Future Directions. *Neurol Int.* Jan 3 2024;16(1):74-94. doi:10.3390/neurolint16010005
- Grafteo CS, Link MJ, Lawton MT. Complex cranial surgery and the future of open cerebrovascular training. *J Neurosurg.* Nov 1 2022;137(5):1554-1561. doi:10.3171/2022.3.Jns212939
- Piazza M, Nayak N, Ali Z, et al. Trends in Resident Operative Teaching Opportunities for Treatment of Intracranial Aneurysms. *World Neurosurg.* Jul 2017;103:194-200. doi:10.1016/j.wneu.2017.03.124