



Original Article

# Evidence-based practice of stereotactic radiosurgery: Outcomes from an educational course for neurosurgery and radiation oncology residents

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Received : 15 August 2020

Accepted : 13 February 2021

Published : 02 March 2021

DOI

10.25259/SNI\_539\_2020

Quick Response Code:



## ABSTRACT

**Background:** As the field of brain and spine stereotactic radiosurgery (SRS) continues to grow, so will the need for a comprehensive evidence base. However, it is unclear to what degree trainees feel properly equipped to use SRS. We assess the perceptions and comfort level reported by neurosurgery and radiation oncology residents concerning the evidence-based practice of SRS.

**Methods:** A continuing medical education (CME) course provided peer-reviewed updates regarding treatment with intracranial and spinal SRS. Presentations were given by neurosurgery and radiation oncology residents with mentorship by senior faculty. To gauge perceptions regarding SRS, attendees were surveyed. Responses before and after the course were analyzed using the Fisher's exact test in R statistical software.

**Results:** Participants reported the greatest knowledge improvements concerning data registries ( $P < 0.001$ ) and clinical trials ( $P = 0.026$ ). About 82% of all ( $n = 17$ ) radiation oncology and neurosurgery residents either agreed or strongly agreed that a brain and spine SRS rotation would be beneficial in their training. However, only 47% agreed or strongly agreed that one was currently part of their training. In addition, knowledge gains in SRS indications ( $P = 0.084$ ) and ability to seek collaboration with colleagues ( $P = 0.084$ ) showed notable trends.

**Conclusion:** There are clear knowledge gaps shared by potential future practitioners of SRS. Specifically, knowledge regarding SRS data registries, indications, and clinical trials offer potential areas for increased educational focus. Furthermore, the gap between enthusiasm for increased SRS training and the current availability of such training at medical institutions must be addressed.

**Keywords:** Conference, Education, Evidence based, Stereotactic radiosurgery

## INTRODUCTION

Stereotactic radiosurgery (SRS) is a highly specialized and complex emerging treatment option for an increasing number of patients with a variety of medical conditions, including malignant and benign tumors, vascular malformations, pain, and psychiatric conditions. A recent survey found that nearly 97% of respondents in a group of radiation oncologists and neurosurgeons

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in US training programs planned to perform brain and spine SRS on graduation. However, over 50% reported below average understanding of intracranial radiosurgery and more than 80% reported below average understanding of spine radiosurgery; nearly 80% cited inadequacies in both the recognition and management of radiosurgery complications.<sup>[16]</sup> Another recent study found that almost half of the polled neurosurgery residents were uncomfortable with radiosurgery techniques and more than half of the faculty indicated that dedicated radiosurgery training would be beneficial but impractical to incorporate into residency.<sup>[14]</sup> In a study from 2010 examining perceptions of neurosurgery residents on radiosurgery training, two-thirds of the residents reported that their training institutions had no formal radiosurgery rotation and a quarter planned to obtain postresidency fellowship training that would include radiosurgery.<sup>[17]</sup> This trend of inadequate SRS exposure and training indicates a greater need for educational reform. In a 2018 study investigating the perceptions of Canadian neurosurgery educators, most respondents believed that there is an increasing role for SRS in neurosurgery and all endorsed a formal residency rotation in radiosurgery.<sup>[15]</sup> SRS is a valued and important part of neurosurgery and there is evidence that residents do not feel adequately prepared to incorporate SRS techniques into their practice after graduation. Moreover, there is a strong evidence suggesting that focused training in SRS would be beneficial.<sup>[8,13,19]</sup>

Radiation oncologists and neurosurgeons during training report suboptimal levels of competence in SRS. Left unaddressed, this issue can lead to suboptimal performance in this highly technical specialty. To assess the perceptions and knowledge of SRS, we polled responses from medical students, attendings, and residents who attended a focused course on evidence-based practice of SRS.

## MATERIALS AND METHODS

A continuing medical education (CME) course hosted by the Radiosurgery Society was held in January 2019 entitled “Evidence-based Practice of Stereotactic Radiosurgery” to update residents and attendings on the most recent data and guidelines concerning intracranial and spinal SRS. This course was designed to provide data from peer-reviewed medical literature regarding indications and treatment of patients with SRS relevant to a range of practitioners including residents, attending physicians, advanced practice providers, and medical physicists. Other emphasized topics of this course included importance of data collection and use in clinical practice, opportunities for interdisciplinary collaborations to improve clinical and translational research, and patient care. The aims of this course were to provide current and prospective practitioners of SRS with the information needed to select appropriate patients for treatment with SRS, perform treatment with maximal safety

and efficacy, and work collaboratively in multidisciplinary teams. The course also focused on increasing resident and SRS practitioner awareness of various SRS data registries and the current landscape of clinical trials.

Presentations were given by neurosurgery and radiation oncology residents and fellows from institutions around the country, with a high representation of residency programs from New York. A panel of attending faculty in neurosurgery and radiation oncology led a discussion after each presentation to critically appraise the research presented and supplement information provided in the presentations with first-hand knowledge and expertise. The faculty residing on the panels was selected for their expertise and engagement in the development and training of neurosurgery and radiation oncology residents at their respective institutions.

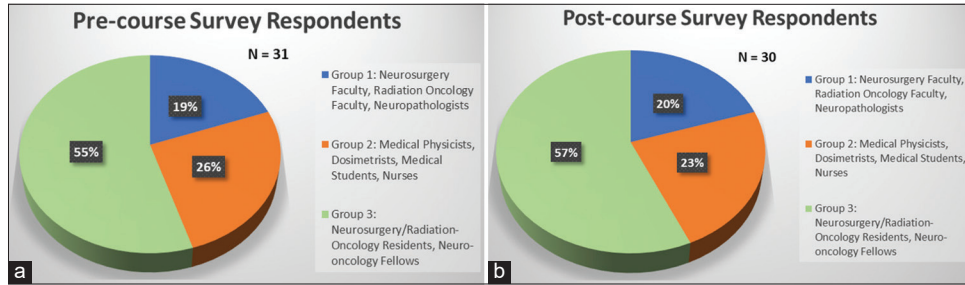
An anonymous online survey was administered to attendees both before and after the course with the goal of evaluating baseline competencies and outcomes from the course as well as demographic details from the attendees. Questions included in the survey were aimed at assessing prior experience with SRS techniques as well as levels of anticipated future use of SRS. Survey questions did not mention the use of techniques specific to any device or technology to avoid introducing conflicts of interest. The survey also evaluated current availability of formal SRS training programs for the U.S. residents at their home institutions. Finally, faculty evaluations of resident preparedness for implementation of SRS within their future practice were included in the survey. Responses remained anonymous, except for the identification of the respondent’s field of practice or training.

## Statistical analysis

Deidentified data were collected from participants of the SRS course. For matched questions that were asked before and after the conference, comparisons were evaluated across three distinct participant groups using a Fisher’s exact test. Statistical analysis was performed using statistical packages in R programming, with a significance threshold of  $P < 0.05$ .

## RESULTS

A total of  $n = 31$  participants completed the precourse survey with a response rate of 50% [Figure 1a]. Level of education and certification of participants were varied, from medical students to attending faculty in neurosurgery and radiation oncology. In the analysis of survey results, participants were divided into predefined groups based on their medical field of practice and training level. Group 1 (19%) consists of six neurosurgery and radiation oncology faculties that responded to the precourse survey. Group 2 (26%) was comprised medical physicists, dosimetrists, medical students, and nurse practitioners. Group 3 (55%) was the largest group



**Figure 1:** (a) Precourse survey respondents divided into groups based on medical specialty and training level. (b) Postcourse survey respondents divided into groups based on medical specialty and training level.

and consisted of neurosurgery residents, radiation oncology residents, and neuro-oncology fellows. A total of  $n = 30$  attendees responded to the postcourse survey [Figure 1b] with a response rate of 48%. Participant groupings remained the same with group proportions staying fairly constant from the precourse survey: Group 1 (20%), Group 2 (23%), and Group 3 (57%).

To evaluate the outcomes of the SRS course on current radiosurgery trainees, residents were assessed for their knowledge on eight defined categories of SRS before and after their participation in the course [Figure 2]. Out of  $n = 17$  residents, survey data were filtered for respondents scoring 4 (above average) or 5 (high) in each knowledge category both before and after the course. In brief, it was observed that participation in the course improved residents' reported knowledge in SRS indications, techniques, comfort in practice, data registries, clinical trials, ability to seek collaborations, and management of complications. Notably, the greatest improvements were observed for residents' knowledge of SRS data registries and clinical trials. None of the residents indicated strong knowledge in SRS data registries before their participation in the course. After the course, 53% of respondents reported a greater understanding of data registries. Minimal difference was observed for residents' interest in pursuing collaborations in SRS. However, the majority (65%) of residents already entered the course with high interest in such collaborations, with 71% of residents expressing high interest after course participation.

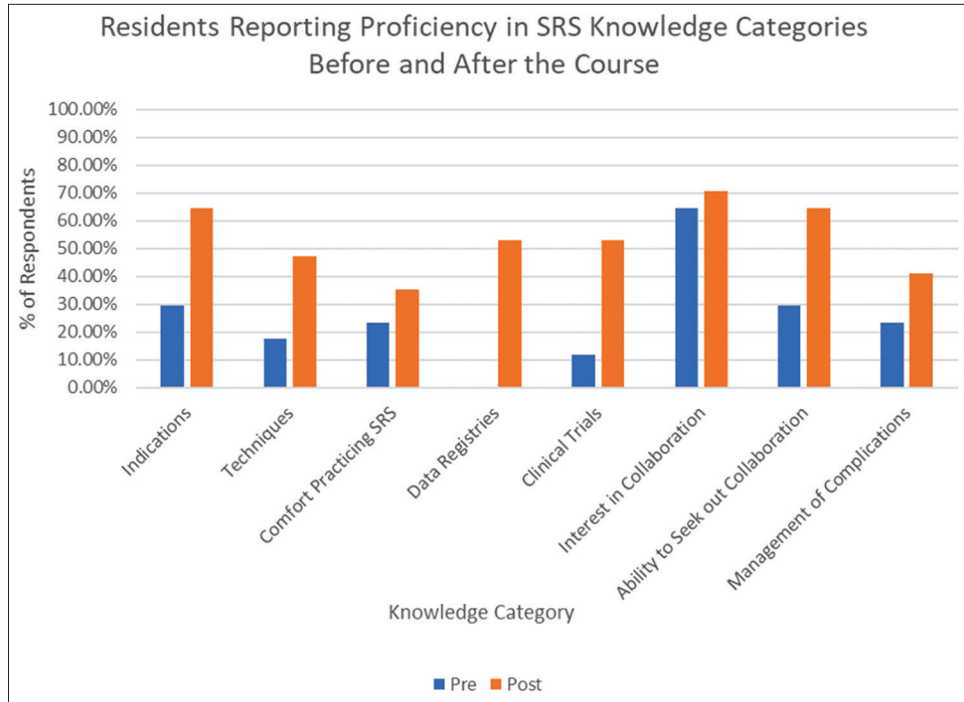
We evaluated whether course participation improved understanding of SRS in three participant groups, as defined above. For each knowledge category, we assessed differences between respondents reporting low proficiency (survey response score = 1, 2, 3) and high proficiency (survey response score = 4, 5) in each group. Group comparisons were analyzed using a Fisher's exact test, with  $P$ -values reported [Table 1]. We observed significant differences in low and high proficiency respondents in Group 2 and Group 3 for their knowledge of data registries and clinical trials before and after course participation. Of particular note, the greatest knowledge gains were observed in data registries ( $P < 0.001$ ) and clinical trials ( $P = 0.026$ ). In addition, though not reaching significance,

**Table 1:**  $P$ -values obtained from Fisher's exact test comparing proportions of participants reporting low proficiency (1, 2, and 3) with those reporting high proficiency (4 and 5) before and after the course for different participant groups defined previously. Of note, knowledge of clinical trials and data registries shows significant differences before and after completion of the course for Groups 2 and 3, as defined by  $P < 0.05$ .

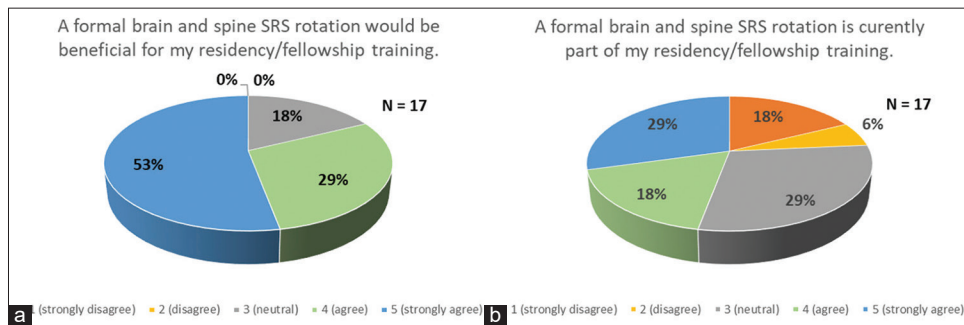
Category	Group 1	Group 2	Group 3
Indications	>0.99	0.12	0.084
Techniques	>0.99	0.31	0.14
Comfort practicing SRS	>0.99	0.61	0.71
Data registries	0.55	<0.01	<0.01
Clinical trials	>0.99	0.026	0.026
Interest in collaboration	>0.99	0.28	>0.99
Ability to seek collaboration	0.45	0.61	0.084
Complication management	>0.99	0.47	0.46

knowledge gains in SRS indications ( $P = 0.084$ ) and ability to seek collaboration with colleagues ( $P = 0.084$ ) show possible increases after the course. Overall, these data suggest that the course improved both residents' general knowledge in SRS and awareness of relevant patient databases and clinical trials.

As part of the postcourse survey, residents and fellows were asked to grade on a Likert scale questionnaire whether they believed that a formal brain and spine SRS rotation would prove beneficial as a part of their training at their home institution [Figure 3a]. Answer choices ranged from 1 (strongly disagree) to 5 (strongly agree). Out of a total of  $n = 17$  respondents, 53% reported that they strongly agree that a brain and spine SRS rotation would be beneficial in their training. About 29% responded that they agree, while 18% remained neutral. Residents and fellows were also asked whether a structured SRS rotation is currently part of their training curriculum at their home institution [Figure 3b]. From the  $n = 17$  respondents, only 29% and 18% reported that they strongly agree or agree, respectively, that a brain and spine SRS program is part of their current training. About 6% disagreed and 18% strongly disagreed with this statement, while 29% remained neutral. In sum, while a total of 82% of residents either strongly agree or agree that a formal brain and spine SRS rotation would be beneficial in their training,



**Figure 2:** Percentages of neurosurgery and radiation oncology residents and fellows reporting above average (4) or high (5) proficiency in relevant stereotactic radiosurgery knowledge categories before and after the course. A significantly higher percentage of residents and fellows report above average or high proficiency in data registries ( $P < 0.001$ ) and clinical trials ( $P = 0.026$ ) after the course compared to reports before the course.



**Figure 3:** (a) Perception of the benefits of an stereotactic radiosurgery (SRS) rotation in residency. Percentages correspond to residents and fellows responding to the survey item regarding whether a formal brain and spine SRS rotation be beneficial as part of their training. (b) Reported prevalence of SRS rotation in residency. Percentages correspond to residents and fellows responding to the survey item regarding whether a formal brain and spine SRS rotation is currently part of their training.

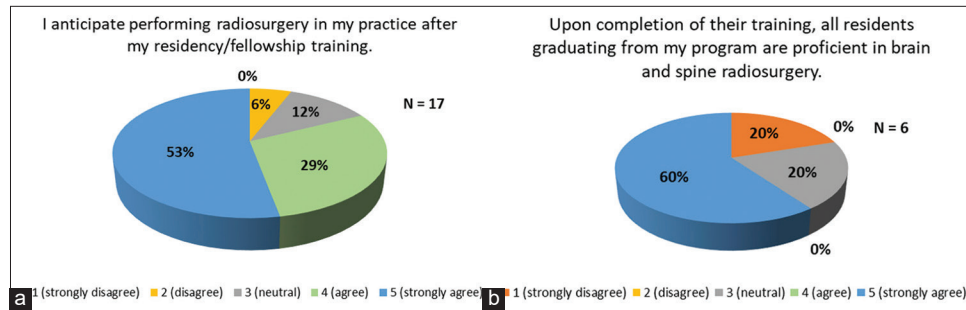
only 47% of these same respondents agree or strongly agree that a brain and spine SRS rotation is indeed a part of their current training at their medical institution.

The postcourse survey also asked residents whether they anticipated performing radiosurgery in their practice after residency and fellowship training [Figure 4a]. Of the  $n = 17$  respondents, 53% strongly agreed and 29% agreed that they anticipated performing radiosurgery after residency training. About 6% disagreed with this statement and 12% remained neutral. None of the survey respondents indicated that they strongly disagreed. Neurosurgery and radiation oncology

faculties were asked to evaluate whether residents graduating from their program were proficient in brain and spine radiosurgery for independent practice [Figure 4b]. Of the  $n = 6$  faculty responding to the survey, 60% strongly agreed with this statement. However, 20% strongly disagreed when asked if their residents would be proficient with brain and spine SRS after graduation.

## DISCUSSION

Results of this survey of neurosurgery and radiation oncology residents indicate a marked discrepancy between



**Figure 4:** (a) Responses from residents and fellows on whether they anticipate performing radiosurgery after residency. (b) Attending physician responses on whether residents in their program are proficient enough to perform brain and spine stereotactic radiosurgery after graduation.

the high level of enthusiasm for the compelling, efficient, and effective treatment modality of SRS and the low level of comfort that practitioners express in managing patients and training residents for independent practice. The results further suggest that significant SRS knowledge gaps can be addressed by providing physicians with the data needed to select appropriate patients for treatment with SRS, to perform treatment with maximal safety and efficacy, and to work collaboratively in multidisciplinary teams.

Didactic presentations, such as this course, are a proven format for delivering information regarding medical evidence to a medical audience. The question and answer period and related discussions allow for appropriate clarification of information presented.<sup>[1,11]</sup> However, based on the particular knowledge gains noted in our survey, this peer-to-peer CME format is particularly advantageous in disseminating information regarding collaborative opportunities, data registries, and clinical trials; knowledge particularly suited for future SRS practitioners at academic institutions. Future iterations of SRS CME courses for residents in neurosurgery and radiation oncology thus may benefit from this core educational format.

In the survey, 47% of residents and fellows indicated formal SRS training at their home institutions. It is unclear what limitations to SRS training accessibility have been encountered by the remaining 53%. For example, it may be the case that cranial and spinal SRS functions as an independent entity at these institutions or that patients are referred elsewhere if they require SRS. Regardless, this lack of access to SRS training may limit the overall educational opportunities for trainees in neurosurgery and radiation oncology. In addressing the knowledge and practice gaps in radiosurgery highlighted by the results in this study, we must consider incorporating changes in residency training. Nevertheless, the continuing concern of balancing duty hours with optimizing resident training poses a challenge for how to incorporate access to additional skills training related to SRS into an already overburdened curriculum.<sup>[6]</sup>

Another method of increasing exposure to SRS during training is by way of postgraduate “boot camps,” simulation-based learning and e-learning resources; all have shown promise in improving performance and in training residents in a time-sensitive manner.<sup>[2-4,7,18]</sup> Studies on junior neurosurgery resident boot camps have demonstrated that individual performance scores for cognitive and procedural skills assessments in PGY-1 residents from the courses correlated with subjective and objective clinical performance evaluations in residency training.<sup>[2,7]</sup> In addition to dedicated boot camps, simulation has shown to be a useful educational tool in resident education.<sup>[3,4]</sup> Fundamental SRS skills training as part of a validated simulation curriculum can mitigate this challenge to residency education and can be a promising strategy to achieve these goals.

Several challenges arise when attempting to reform residency training with the above or other methods. Hesitance to include trainees in the treatment planning and delivery of SRS may hinge on fears of introducing new complications to patients from the involvement of nonindependent practitioners. However, a multicenter study demonstrated that resident involvement in the neurosurgical operating room was not a significant factor for postoperative complications in neurosurgery service and that much of the observed difference in postoperative complication rates was attributable to other confounding factors.<sup>[12]</sup> Moreover, there are also other subspecialties, such as neuro-oncology, within neurosurgery that would benefit from improved resident training.<sup>[10]</sup> Furthermore, given that residents in radiation oncology report less than 80 hours of clinical work per week, there may be an opportunity to enhance their training with an option for more focused exposure to brain and spine SRS for those who do not already have this training available.<sup>[5]</sup> The application of SRS requires a partnership between radiation oncology and neurosurgery; this partnership can be fostered during postgraduate training.<sup>[9]</sup>

Several limitations of our study merit discussion. First, because New York residency training programs were highly represented in our study, this may limit the generalizability

of our findings to reflect more regional training practices. Second, our pre- and postcourse response rates of 50% and 48%, respectively, indicate the potential for response bias. It may be the case that respondents were composed of those most enthusiastic about SRS and thus were more likely to advocate for increased SRS training. However, this is not corroborated by the finding that 53% of respondents were not receiving formal SRS training. Rather, this indicated that the CME course captured a population of residents who lacked formal training in SRS which could benefit from educational sessions taught within this CME framework. Further, response rates of 50% are quite reasonable in most survey studies. Finally, this survey likely could not adequately capture those populations who are not interested in SRS or those who are pursuing SRS with adequate training outside of this CME course. This would require larger sample sizes to capture nationwide trends in SRS training. However, based on these initial findings from neurosurgery and radiation oncology residents, there is some indication that a discrepancy remains between enthusiasm for SRS and access to formal training. Future work with larger participant pools across multiple institutions is warranted to validate these findings within a greater scope. Results of these nationwide investigations may help advocate for increased SRS training and guide modifications to existing residency training.

## CONCLUSION

SRS is an increasingly utilized technology in the management of a wide variety of clinical conditions. The results of this study indicate that while residents and practitioners express great enthusiasm for this emerging specialty, they also self-report deficiencies in their ability to recognize indications, perform treatment, and manage complications utilizing SRS techniques within an evidence-based framework. This discrepancy poses a hurdle in the ability to utilize SRS with improved safety and efficacy and suggests a need for residency training reform to incorporate increased, focused exposure to brain and spine SRS for neurosurgery and radiation oncology residents.

## Acknowledgment

The authors wish to acknowledge the support of this program by Kristine Gagliardi and the Radiosurgery Society.

## Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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**How to cite this article:** Chidambaram S, Guadix SW, Kwon J, Tang J, Rivera A, Berkowitz A, *et al.* Evidence-based practice of stereotactic radiosurgery: Outcomes from an educational course for neurosurgery and radiation oncology residents. *Surg Neurol Int* 2021;12:77.