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2397 Waterbury Circle, Suite 1,
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Key Takeaways From the ISASS Webinar Series on Current and Emerging Techniques in Endoscopic Spine Surgery | Part 2: Polytomous Rasch Analysis of Learning Curve and Surgeon Endorsement of Biportal, Interlaminar, and Transforaminal Endoscopic Stenosis Decompression, Discectomy, and Laminectomy in Combination With Interspinous Process Spacers

KAI-UWE LEWANDROWSKI, MD[1,2,3,4†]; GREGORY W. BASIL, MD[5]; BRIAN KWON, MD[6]; XINYU LIU, MD[7]; GABRIEL OSWALDO ALONSO CUÉLLAR, DVM, EdM, MSc[8,9]; PAULO SERGIO TERXEIRA DE CARVALHO, MD, PhD[10‡]; AND MORGAN P. LORIO, MD, FACS[11§]

[1]Division Personalized Pain Research and Education, Center for Advanced Spine Care of Southern Arizona, Tucson, AZ, USA; [2]Department of Orthopaedic Surgery, University of Arizona, Banner Medical Center, Tucson, AZ, USA; [3]Department of Orthopaedics, Fundación Universitaria Sanitas, Bogotá, Bogotá D.C., Colombia; [4]Department of Orthopedics, Hospital Universitário Gaffree Guinle Universidade Federal do Estado do Rio de Janeiro, Rio de Janeiro, Brazil; [5]Department of Neurosurgery, University of Miami, Miller School of Medicine, Miami, Miami, FL, USA; [6]New England Baptist Hospital, Boston, MA, USA; [7]Qilu Hospital of Shandong University, Jinan, China; [8]Latin American Endoscopic Spine Surgeons LESS Invasiva Academy, Bogotá, Colombia; [9]Department of Orthopaedic Surgery, Clínica Reina Sofía—Clínica Colsanitas, Bogotá, D.C., Colombia; [10]Department of Neurosurgery, Hospital Universitário Gaffree Guinle Universidade Federal do Estado do Rio de Janeiro, Rio de Janeiro, Brazil; [11]Advanced Orthopedics, Altamonte Springs, Orlando College of Osteopathic Medicine, Orlando, FL, USA

[†]International Society for the Advancement of Spine Surgery, Interamerican Society For Minimally Invasive Spine Surgery - La Sociedad Interamericana de Cirugía de Columna Mínimamente Invasiva (SICCMI), International Intradisccal Therapy Society (IITS.org); [‡]Interamerican Society for Minimally Invasive Spine Surgery - La Sociedad Interamericana de Cirugía de Columna Mínimamente Invasiva (SICCMI); [§]International Society for the Advancement of Spine Surgery

K-UL, 0000-0001-7842-2914; GWB, 0000-0002-1257-6504; BK, 0000-0002-5337-0924; GOAC, 0000-0001-7350-489X; MPL, 0000-0003-1623-2095

ABSTRACT

Background: The International Society for the Advancement of Spine Surgery hosted the second of a series of 4 webinars on endoscopic spine surgery techniques. The second webinar focused on the application of unilateral biportal endoscopy for discectomy and laminectomy in combination with interbody fusion and interspinous process spacers. This series was intended to identify current trends with contemporary modern endoscopic spine surgery techniques.

Objective: To analyze the level of surgeon endorsement for the presented endoscopic spine surgery techniques before and after the webinar utilizing polytomous Rasch analysis, as well as to evaluate the potential for these insights to inform clinical guideline recommendations.

Methods: A survey was available to 667 potential respondents during the Zoom webinar, collecting data on surgeon endorsements using a Likert scale. The polytomous Rasch model was employed to analyze responses while considering the complexity of decisions against surgeon expertise, developing a logarithmic measurement scale, allowing objective statistical analysis of categorical variables, highlighting incongruent or out of order items vs congruent and in order items, and driving improvement in clinical guidelines.

Results: Of the 667 surgeons who participated in the webinar, 224 accessed, 122 started, and 61 completed the prewebinar survey, achieving a 50.0% completion rate. Respondents comprised primarily orthopedic surgeons (70.5%) and neurosurgeons (24.6%), with fellows and medical students each making up 1.6%. These surgeons estimated that mastering the learning curve of endoscopic spine surgery required an average of 18.08 cases corroborated by postwebinar responses averaging 15.78 cases. Descriptive statistics revealed an acknowledgment of a learning curve in mastering endoscopic spine surgery, with a slight increase in recognition postwebinar (81.8% up from 80.3%). The data underscored the importance of cadaver courses and high-volume surgical practice before the webinar and highlighted the value of mentorship afterward, indicating a preference shift toward more interactive learning. The confidence in various endoscopic techniques saw notable changes, particularly for procedures involving interlaminar lateral canal decompression and the combined use of transforaminal endoscopic decompression with interspinous process spacers, which saw an increase in high-level endorsements postwebinar. Polytomous Rasch analysis provided insights into training methods and procedural techniques, with mentorship and cadaver courses emerging as key elements for mastering the learning curve. The analysis also highlighted a general consensus on the effectiveness of percutaneous endoscopic interlaminar decompression for lateral canal stenosis, reflecting evolving surgeon preferences and consensus on best practices. Infit and outfit statistics from the Rasch analysis suggested a good fit between the survey responses and the Rasch model both before and after the webinar, indicating minimal data distortion due to bias. Differential item functioning analysis showed no significant bias in item responses between orthopedic surgeons and neurosurgeons in the prewebinar survey, but it identified potential bias for one item postwebinar—unilateral biportal endoscopic laminectomy for central stenosis.

Conclusion: This webinar highlighted the importance of hands-on training methods such as cadaver courses and mentorship in mastering the complex spinal endoscopy procedures. The application of polytomous Rasch analysis provided a detailed understanding of surgeons' current preferences and perceptions, as well as the evolving consensus on best practices in endoscopic spine surgery, displaying wide acceptance of the percutaneous interlaminar endoscopic decompression for lateral canal stenosis decompression and a growing interest in integrating endoscopic techniques for more comprehensive spinal care, including wide decompression and spinal stabilization.

Clinical Relevance: Assessing surgeon confidence and acceptance of endoscopic spinal surgeries using polytomous Rasch analysis.

Level of Evidence: Level 2 (inferential) and 3 (observational) evidence because Rasch analysis provides statistical validation of instruments rather than direct clinical outcomes.

Endoscopic Minimally Invasive Surgery

Keywords: endoscopic spine surgery, polytomous Rasch analysis, surgeon endorsement, unilateral biportal endoscopy (UBE), percutaneous endoscopic interlaminar decompression (PEID), discectomy, laminectomy, interspinous process spacers (ISP), clinical guidelines, learning curve

INTRODUCTION

In early 2024, the International Society for the Advancement of Spine Surgery (ISASS) hosted the second in a 4-part webinar series on the forefront of endoscopic spine surgery. This session, which aimed to spread knowledge and stimulate dialog about new techniques in lumbar spinal stenosis treatment, focused on overcoming initial learning curve challenges, unilateral biportal endoscopic laminectomy and discectomy, percutaneous endoscopic interlaminar decompression for treating lumbar spinal stenosis, and lumbar transforaminal endoscopic decompression alongside interspinous process spacer implantation. Insights from these discussions were captured through surveys conducted before and after the webinar. Using polytomous Rasch analysis, the webinar explored participants' acceptance of each topic and procedure, emphasizing the swift progress and detailed evidence supporting patient-centered minimally invasive surgery. This method provided a comprehensive review of attendee perceptions, experiences, and reported outcomes, forming a solid basis for assessing these endoscopic techniques' effectiveness and surgeon satisfaction levels. The findings could contribute to developing clinical guidelines for endoscopic spine surgery.

Briefly, incorporating the Rasch model, based on item response theory (IRT),[1–8] this study introduces a sophisticated framework for analyzing responses from the second in a series of 4 webinars on endoscopic spine surgery. This model adeptly navigates the probabilistic aspects of decision-making by juxtaposing task difficulty with individual proficiency,[8] making it an ideal tool for dissecting levels of agreement on discussed topics. Spine surgery, which is inherently reliant on a blend of experience, skill, and variable external factors, presents unique challenges that traditional statistical analyses of patient-reported outcomes or surgeon decisions fail to adequately address. The Rasch model, by treating categorical data such as Likert-scale responses with mathematical precision, overcomes these limitations and offers several key advantages: it assesses the complexity of decisions in the context of a surgeon's expertise, thus providing a more nuanced understanding; it transforms ordinal data into a precise interval-level scale, improving accuracy in comparisons and supporting professional development; it ensures consistent measurement across diverse surgical decisions, enabling reliable comparisons; it identifies anomalous items, sharpening tools for evaluating surgical judgment; and it drives educational and guideline improvements by revealing specific areas of strength and weakness in decision-making, thus enhancing surgical outcomes. Utilizing the polytomous Rasch model, the present article strives to convert the expert knowledge shared during the webinar into practical insights for evaluating clinical evidence based on surgeon feedback.

MATERIALS AND METHODS

Webinar and Surgeon Survey

The authors disseminated an online questionnaire through www.typeform.com to 667 potential surgeon participants using a link shared during the ISASS-hosted Zoom webinar on 12 March 2024. Participants were requested to rate their support for or the significance

Figure 1. Webinar moderator (Kai-Uwe Lewandrowski, MD) and presenters who presented on the following topics: Gregory Basil, MD, Assistant Professor of Neurosurgery and Director of Endoscopic Spine Surgery at the University of Miami, Miller School of Medicine, discussed overcoming the steep learning curve associated with spinal endoscopy, emphasizing the importance of education and structured training programs. Brian Kwon, MD, of New England Baptist Hospital and Assistant Clinical Professor of Orthopedic Surgery at Tufts University School of Medicine, presented insights on biportal endoscopic laminectomy/discectomy and endoscopic transforaminal lumbar interbody fusions focusing on the advantages and challenges of these minimally invasive approaches. Xinyu Liu, MD, from Qilu Hospital of Shandong University, presented a comparative analysis of clinical outcomes and muscle invasiveness between unilateral biportal endoscopic decompression and percutaneous endoscopic interlaminar decompression for lumbar spinal stenosis, highlighting differences in recovery and postoperative complications. Last, Gabriel Oswaldo Alonso Cuéllar, DVM, EdM, MSc, from the Latin American Endoscopic Spine Surgeons LESS Invasiva Academy in Bogotá, Colombia, explored the innovative technique of lumbar endoscopic decompression combined with simultaneous interspinous process spacer implantation for the treatment of spinal stenosis, offering insights into long-term outcomes and functional recovery.

they placed on the 4 topics discussed at the webinar. Ratings were given on a Likert scale ranging from 1 (low) to 5 (high). This assessment was conducted at both the start and the end of the webinar to gauge changes in the participants' levels of endorsement resulting from the lectures presented. The webinar presenters introduced the following 4 topics (Figure 1):

1. "Overcoming the Learning Curve in Spinal Endoscopy" by Gregory Basil, MD, Assistant Professor of Neurosurgery, Director Endoscopic Spine Surgery, University of Miami, Miller School of Medicine.
2. "Biportal Endoscopic Laminectomy/Discectomy and Endoscopic Transforaminal Lumbar Interbody Fusion" by Brian Kwon, MD, New England Baptist Hospital, Assistant Clinical Professor of Orthopedic Surgery at Tufts University School of Medicine.
3. "Clinical Outcomes and Muscle Invasiveness Between Unilateral Biportal Endoscopic Decompression and Percutaneous Endoscopic Interlaminar Decompression for Lumbar Spinal Stenosis" by Xinyu Liu, Qilu Hospital of Shandong University, Jinan City, Shandong Province, People's Republic of China.
4. "Lumbar Endoscopic Decompression with Simultaneous Interspinous Process Spacer Implantation for Spinal Stenosis" by Gabriel Oswaldo Alonso Cuéllar, DVM, EdM, MSc, Latin American Endoscopic Spine Surgeons LESS Invasiva Academy, Bogotá, Colombia.

Additionally, surgeons were asked to provide details about their postgraduate education and years in practice.

Statistics and Rasch Analysis

The data were exported to Excel and then analyzed using IBM SPSS (version 27) and Jamovi (version 2.3) software. The analysis employed descriptive metrics to quantify replies and compute means, ranges, deviations, and percentages. The χ^2 test gauged the correlation between variables. The Jamovi IRT module was used for the Rasch analysis. A P value below 0.05 was deemed significant, with a 95% confidence interval applied to all statistical evaluations. The polytomous Rasch model analysis described by Andrich[6] employed in this surgeon survey analysis was explained in detail in the Part 1 report. When employed in a specific empirical scenario, this model posits that the likelihood of a certain result is a probabilistic outcome driven by these individual and item characteristics. Ordered response data incorporate the likelihood of an answer falling into a specific category (for instance, the chance of choosing strongly agree, agree, disagree, or strongly disagree). In the polytomous Rasch model, a score of x on a given item implies that an individual has simultaneously surpassed x thresholds below a certain region on the continuum and failed to surpass the remaining $m - x$ thresholds above that region. In mathematical terms, the Rasch model application in the authors' study represents the log odds (or logit) of a person endorsing an item as the difference between the person's ability or level of partial agreement and the item's difficulty. This model employs χ^2 fit statistics to control the applicability of data to the model. The χ^2 in common use are known as outfit and infit. In this study, the results of the polytomous Rasch analysis are graphically displayed in the Wright plot[9] and person-item map analysis.[10]

Sample Size

For the Rasch model, there is a symmetry in requirements: a stable measure of persons necessitates as many items as the number of individuals needed for stable item calibration. Therefore, administering 30 items to 30 participants, assuming adequate targeting and fit, is expected to yield statistically stable measures (within ±1.0 logits at a 95% confidence level), as verified by Azizan et al.[11]

Bias Detection

Rasch analysis is adept at detecting various forms of disturbances in data, including bias, through the examination of residuals—the differences between the observed responses and the responses predicted by the model. Rasch analysis produces fit statistics for each item, which indicate how well the responses to that item fit the expectations of the Rasch model. The outfit mean square (often simply called "outfit") is an unweighted mean square error statistic. It is more sensitive to outliers or unexpected responses that are far from what the model predicts. Outfit statistics are expressed as a ratio of the observed variance to the expected variance. A perfect fit to the model would have a value of 1.0. Outfit values larger than 1.0 indicate unmodeled noise. Values are on a ratio scale; so, for example, 1.2 indicates 20% excess noise. Values less than 1.0 indicate overfit of the data to the model (ie, the observations are too predictable). Infit is an information-weighted form of outfit. The weighting reduces the influence of less informative, low variance, and off-target responses. Items that do not fit well might be functioning differently for different subgroups of respondents. Fit statistics include both infit (information-weighted fit) and outfit (outlier-sensitive fit) statistics, with misfitting items potentially indicating biased items. Bias in test items, often referred to as differential item functioning (DIF),[12] occurs when surgeons from different groups (eg, based on postgraduate training or clinical experience) with the same underlying ability do not have the same probability of answering an item as expected. The difNLR() and difORD() functions were employed where the difNLR() performs DIF detection procedure for dichotomous data based on a nonlinear regression model (generalized logistic regression) and either likelihood-ratio or F test of the submodel, and the difORD() performs DIF detection procedure for ordinal data based on either an adjacent category logit model or a cumulative logit model and likelihood ratio test of the submodel.[13]

The graphical tools employed this study, such as person-item maps, the Wright plots, and the item characteristic curves, were employed in this study to visually inspect how items perform across groups and to detect bias by additionally examining the infit and outfit statistics. Infit and outfit numbers between 0.6 and 1.4 have been referenced as acceptable suggesting lack of distortion in the data. The authors also employed the MAPQ3 methodology rooted in IRT analysis, with numbers of 0.3 or less suggesting the absence of data distortion. These tools can help identifying items that disproportionately favor or disadvantage specific subgroups. Considering that Rasch analysis is specialized for measuring latent traits and detecting item bias within tests or surveys,[13] the authors considered it more sensitive to bias in the context of this study than regression or analysis of variance (ANOVA) analysis.

RESULTS

The second part of the webinar series "Current and Emerging Techniques in Endoscopic Spine Surgery," hosted by ISASS, attracted 667 surgeons online at the beginning of the webinar. Of these, 224 accessed the prewebinar survey, 122 started it, and 61 submitted a complete survey, resulting in a completion rate of 50.0%. The respondents were orthopedic surgeons (70.5%), neurosurgeons (24.6%), fellows (1.6%), and medical students (1.6%). The practice experience of surgeons responding to the prewebinar survey ranged from 1 to 40 years, with mean of 16.42 ± 12.39 years. The mean number of cases required to master the learning curve indicated by these surgeons was 18.08 ± 16.67464, ranging from 1 to 100. The postwebinar demographics were similar, with orthopedic surgeons (67.3%), neurosurgeons (25.5%), fellows (1.8%), residents (1.8%), and medical students (1.8%) responding. The mean number of years in practice was 17.05 ± 9.33, ranging from 1 to 40 years. The mean number of cases required to master the learning curve indicated by these surgeons in the postwebinar survey was 15.78 ± 9.12, ranging from 1 to 35. The postwebinar was accessed by 122 surgeons, of whom 74 started it and 55 submitted a complete survey, resulting in a completion rate of 74.3%.

The polytomous Rasch analysis conducted on participants' responses from the second ISASS webinar provided insightful data on endorsing various endoscopic procedures before and after the webinar. Besides the items considered to be relevant to mastering the learning curve, the procedures analyzed included the following:

1. unilateral biportal endoscopic laminectomy for central stenosis (UBE LAM STEN)
2. unilateral biportal endoscopic laminectomy for herniated disc (UBE LAM HNP)
3. unilateral biportal endoscopic decompression for lateral canal stenosis (UBE STEN)
4. percutaneous interlaminar endoscopic decompression for lateral canal stenosis (PEID)

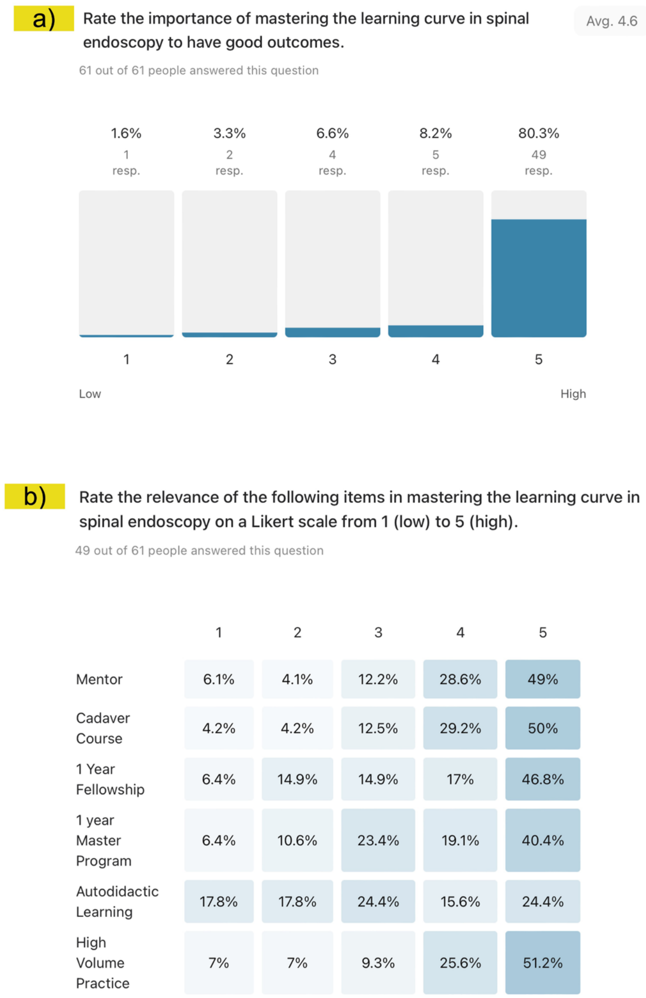

Figure 2. Prewebinar descriptive statistics of the level of importance of the learning curve to master endoscopic spine surgery: (a) 80.3% of surgeons indicated that there is a learning curve to overcome. (b) The percentage breakdown from low- to high-level endorsement is shown within each learning item. Approximately half of the responding surgeons endorsed cadaver courses and high-volume surgical practice as essential elements in overcoming the learning curve. Receiving supervised training during a 1-year fellowship or master's program was less supported. Autodidactic learning was considered the least appropriate.

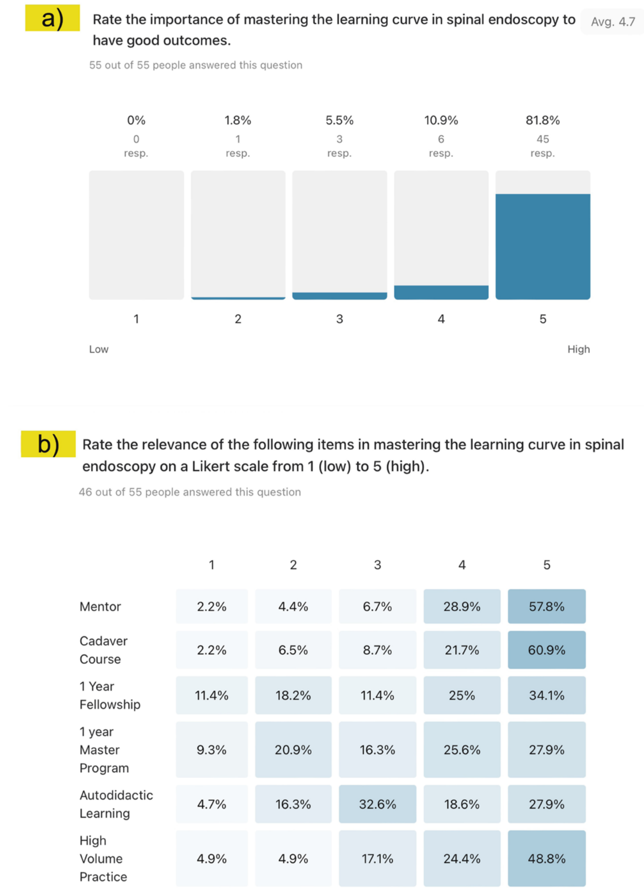

Figure 3. Postwebinar descriptive statistics of the level of importance of the learning curve to master endoscopic spine surgery: (a) 81.8% of surgeons indicated that there is a learning curve to overcome. (b)The percentage breakdown from low- to high-level endorsement is shown within each learning item. More than half of respondents strongly endorsed cadaver courses (60.9%) and having a mentor (57.8%) in overcoming the learning curve. A high-volume surgical practice (48.8%) was also seen as essential in overcoming the learning curve. Receiving supervised training during a 1-year fellowship (34.1%) or master's (27.9%) program was less supported. Autodidactic learning (27.9%) also lacked high-level support.

5. transforaminal endoscopic decompression with simultaneous interspinous process spacer for lateral canal stenosis (Endo + ISP)

Descriptive Statistics of Learning Curve Assessment, Clinical Outcomes, and Endoscopic Techniques

Figures 2 and 3 reveal that most surgeons acknowledged a learning curve in mastering endoscopic spine surgery, with prewebinar statistics showing 80.3% and postwebinar figures slightly higher at 81.8%. The importance of overcoming this learning curve was underscored by the endorsement of cadaver courses and high-volume surgical practice in the prewebinar survey. Interestingly, the postwebinar data also emphasized the value of having a mentor, highlighting a slight shift in preferences toward more interactive and guided learning methods. The lesser support for autodidactic learning methods and formalized fellowship or master's programs remained consistent, suggesting a preference for practical, hands-on experience under a mentor's guidance over theoretical learning.

The shift in confidence levels regarding various endoscopic techniques is illustrated in Figures 4 and 5. Prewebinar survey responses showed higher-level endorsements for the interlaminar lateral canal decompression (43.5%). The highest endorsement for the UBE central canal decompression for stenosis was 34.5%, and the highest disapproval for herniated discs was 35.2%. Only 27.9% of surgeons gave a high-level endorsement for the combination of transforaminal

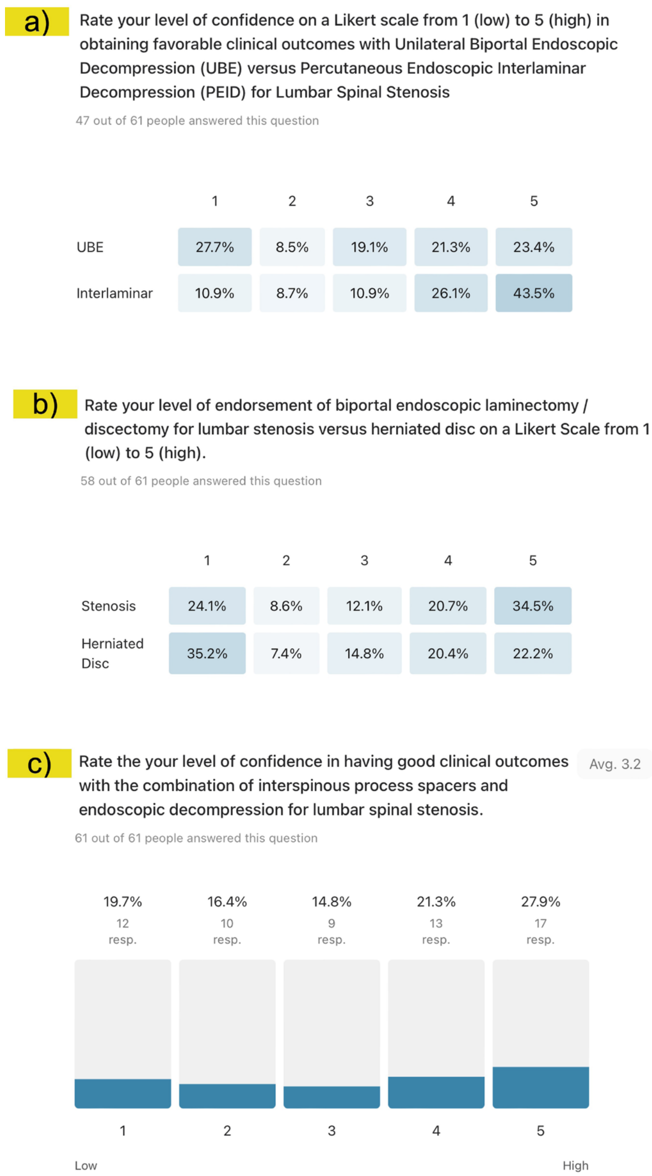

Figure 4. Prewebinar descriptive statistics of level of confidence in achieving favorable clinical outcomes with (a) lateral canal decompression done either with unilateral biportal endoscopic (UBE) decompression or with percutaneous endoscopic interlaminar decompression, (b) UBE decompression for either central canal stenosis or herniated disc, and (c) transforaminal endoscopic decompression and simultaneous placement of an interspinous process spacer (ISP). Prewebinar survey responses showed higher-level endorsements for the interlaminar lateral canal decompression (43.5%; a). The highest endorsement for the UBE central canal decompression for stenosis was 34.5%, and the highest disapproval for herniated discs was 35.2% (b). Only 27.9% of surgeons gave a high-level endorsement for the combination of transforaminal endoscopic decompression with simultaneous placement of an ISP, with nearly equal levels of endorsement throughout the other categories (c).

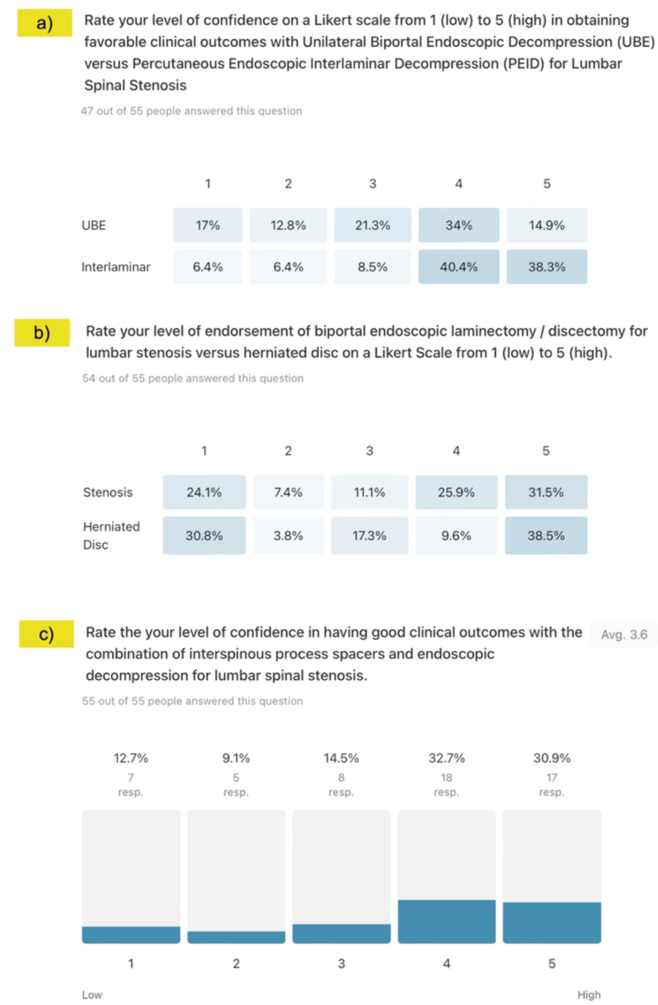

Figure 5. Postwebinar descriptive statistics of level of confidence in achieving favorable clinical outcomes with (a) lateral canal decompression done either with unilateral biportal endoscopic (UBE) decompression or with percutaneous endoscopic interlaminar decompression, (b) UBE decompression for either central canal stenosis or herniated disc, and (c) transforaminal endoscopic decompression and simultaneous placement of an interspinous process spacer. Postwebinar survey responses showed an endorsement shift to higher-level categories (levels 4 and 5) for the interlaminar lateral canal decompression (78.7%), up from 67.6%, and the UBE lateral canal decompression of 48.9% up from 44.7% (a). There was a minimal response shift for the UBE laminectomy decompression of the central canal for either stenosis or herniated disc (b). There was an endorsement for the combination of transforaminal endoscopic decompression with simultaneous placement of an interspinous process spacer with a high-level endorsement (categories 4 and 5) of 63.6%, up from 49.2% prewebinar (c).

endoscopic decompression with simultaneous placement of an ISP, with nearly equal levels of endorsement throughout the other categories. Postwebinar responses indicate an increase in surgeons' confidence in achieving favorable clinical outcomes through interlaminar lateral canal decompression and the use of interspinous process spacers in combination with transforaminal endoscopic decompression with a high-level endorsement (category 4 and 5) of 63.6%, up from 49.2% compared with the prewebinar survey. There were higher-level endorsements for categories level 4 and 5 for the interlaminar lateral canal decompression (78.7%), up from 67.6%, and the UBE lateral canal decompression of 48.9% up from 44.7% compared with the prewebinar survey. There was a minimal response

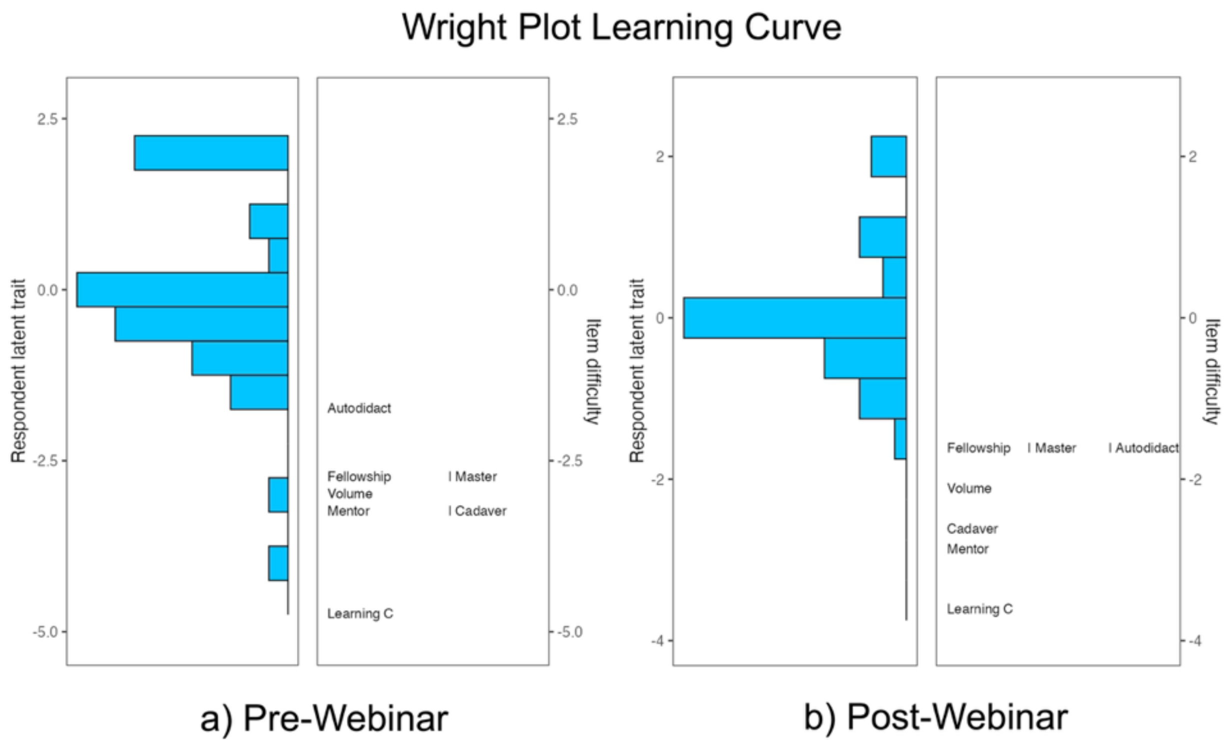

Figure 6. Wright plot obtained in the polytomous Rasch analysis of prewebinar (left panel) and postwebinar (right panel) survey responses regarding the importance of mastering the endoscopy learning curve, which was the easiest item for responding surgeons to agree on. The item response theory polytomous Rasch partial agreement analysis was employed to assess spine surgeons' level of endorsement of the 6 frequently employed endoscopic spine surgery training methods (test items). On the left side of the Wright plot, the responding surgeons' latent traits are written in logits (log odds) as estimates of true intervals of item difficulty and surgeon ability and intensity of partial agreement. The surgeons, represented by horizontal bars at the top, represented the highest level of endorsement. On the right of the Wright plot, the harder-to-agree-on items are listed at the top vs the easier-to-agree-on ones at the bottom. Directly across from 0, those surgeons had a 50% chance of endorsing a test item. There were 4 assessment gaps on the prewebinar survey and 1 on the postwebinar survey. There was some redundancy between prewebinar test items, as shown by the same ranking for fellowship and master program and mentorship and cadaver course. Similar redundancy existed for test items fellowship and master program, as well as autodidactic learning in the postwebinar survey. Cadaver course and mentorship were the most preferred elements in the training of future endoscopic spine surgeons.

shift for the UBE laminectomy decompression of the central canal for either stenosis or herniated disc.

Polytomous Rasch Analysis

As demonstrated in Figures 6 through 9, the use of the polytomous Rasch analysis offered a nuanced understanding of surgeons' intensity of endorsements of various training methods and procedural techniques. The Wright plots (Figure 6) highlighted a consensus among surgeons on the importance of mentorship and cadaver courses in mastering the learning curve despite some redundancy between prewebinar test items, as shown by the same ranking for fellowship and master programs and mentorship and cadaver course. There was also a similar redundancy in the ranking of test items for fellowship and master programs as well as autodidactic learning in the postwebinar survey. Cadaver courses and mentorship were the easiest elements to agree on in the training of future endoscopic spine surgeons. In comparison to prewebinar descriptive statistics (Figure 2), the corresponding prewebinar survey Person Item Map (Figure 7) revealed that the most high-intensity items were "autodidactic learning style," "surgical master program in endoscopic spine surgery," and having a "high volume practice" with the mean logit location shifted to the right. Since these items were out of order, some surgeons could not be measured as reliably as the majority by this set of items, indicating the test items were either too intense or not intense enough for them. The analysis also showed disordered thresholds of endorsement for the 5 of 6 test items. Except for "attending a cadaver course," all test items were out of order in the prewebinar survey, suggesting that surgeons had difficulty consistently discriminating between response categories. In the prewebinar survey, the mean logit locations for items "1-year fellowship" and "mentorship" suggested less intense partial agreement for these items. Response analysis from the postwebinar survey for items "surgical master program in endoscopic spine surgery," "attending a cadaver course," "1-year fellowship," and "mentorship" showed that the webinar

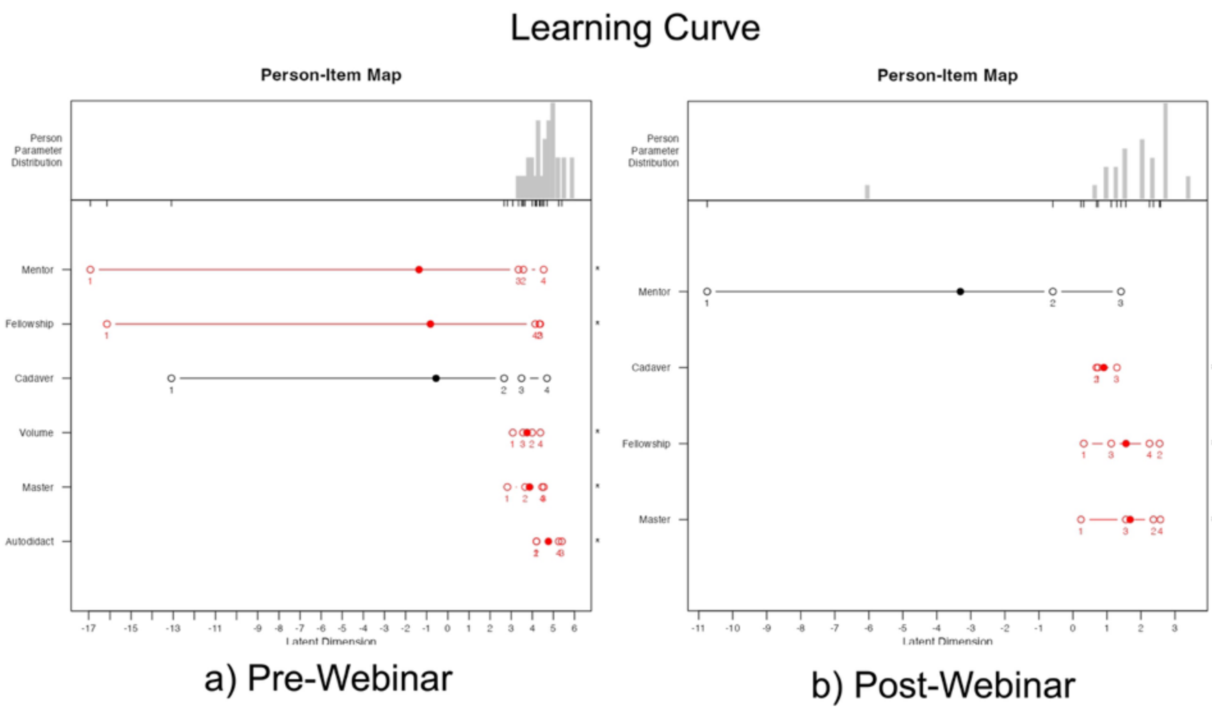

Figure 7. The person-item map of prewebinar (a) and postwebinar (b) survey responses shows the logarithmically transformed person and item positions on a unified continuum using the logit measurement unit, transitioning ordinal data to equal-interval data. This method charts both person and item positions (in logits) along the x axis. Within Rasch modeling, these values are labeled as "locations" rather than "scores." A surgeon's logit location indicates their natural log odds of agreement with a series of items. Individuals with pronounced adherence to the considered attitude affirm items favorably, positioning them further to the right on the scale. The solid dots indicate the mean person location scores. Disordered items are shown in red and ordered ones in black. Examining the order and location of these test items reveals an uneven distribution of the ranked order of item difficulties or intensities along the logit continuum, suggesting a poor fit to the Rasch model without any statistically significant difference between the observed values and the values predicted by the model. In comparison to prewebinar descriptive statistics (Figure 1), the most high-intensity items were "autodidactic learning style," "surgical master program in endoscopic spine surgery," and having a "high volume practice" with the mean logit location shifted to the left. Because these items were out of order, some surgeons could not be measured as reliably as the majority by this set of items, indicating the test items were either too intense or not intense enough for them. The analysis also showed disordered thresholds of endorsement for the 5 of 6 test items. With the exception of "attending a cadaver course," all test items were out of order (logits shown in red) in the prewebinar survey suggesting that surgeons had difficulty consistently discriminating between response categories ranging from strongly disagree (1), disagree (2), agree (3), and strongly agree (4)—a problem observed when there are too many response options not measuring the opinions. In the prewebinar survey, the mean logit locations for items "1-year fellowship" and "mentorship" were more shifted to the left of the plot and had an out of order (logits shown in red) wider spread, therefore showing less intense partial agreement for these items. Response analysis from the postwebinar survey for items "surgical master program in endoscopic spine surgery," "attending a cadaver course," "1-year fellowship," and "mentorship" showed that the webinar shifted participants' perceptions of the importance of having a mentor. This item solicited the highest in-order intensity response. In summary, the Rasch analysis of incoming pre- and postwebinar responses suggested that most surgeons considered having a mentor and attending cadaver courses as the most effective way to master the learning curve in endoscopic spine surgery. The person-item maps also illustrates that items were reasonably well distributed.

shifted participants' perception of the importance of having a mentor. This item solicited the highest in-order intensity response. In summary, the Rasch analysis of incoming pre- and postwebinar responses suggested that most surgeons considered having a mentor and attending cadaver courses the most effective way to master the learning curve in endoscopic spine surgery. The person-item maps also illustrated that items were reasonably well distributed.

Additionally, the analysis of procedural endorsements revealed a complex framework, where percutaneous endoscopic interlaminar decompression for lateral canal stenosis gained widespread acceptance, illustrating the dynamic nature of surgeon preferences and the evolving consensus on best practices in endoscopic spine surgery. The corresponding Wright plots (Figure 8) showed no assessment gaps in the prewebinar survey but 2 in the postwebinar survey. Prewebinar survey analysis showed the log ranking for UBE STEN, UBE LAM STEN, and Endo + ISP with similar locations in the Wright plot, suggesting some redundancy between test items and that surgeons had difficulty discriminating them based on the survey questions. In the postwebinar survey, the items UBE LAM HNP, UBE LAM STEN, and UBE STEN were the most challenging to agree on. After the webinar, surgeons agreed more readily with the information presented on the test item "Endo + ISP." The item PEID was the easiest to agree on before and after the webinar, suggesting the wide acceptance of PEID among endoscopic spine surgeons in treating lateral canal stenosis and HNP. The corresponding person-item map (Figure 9) showed that

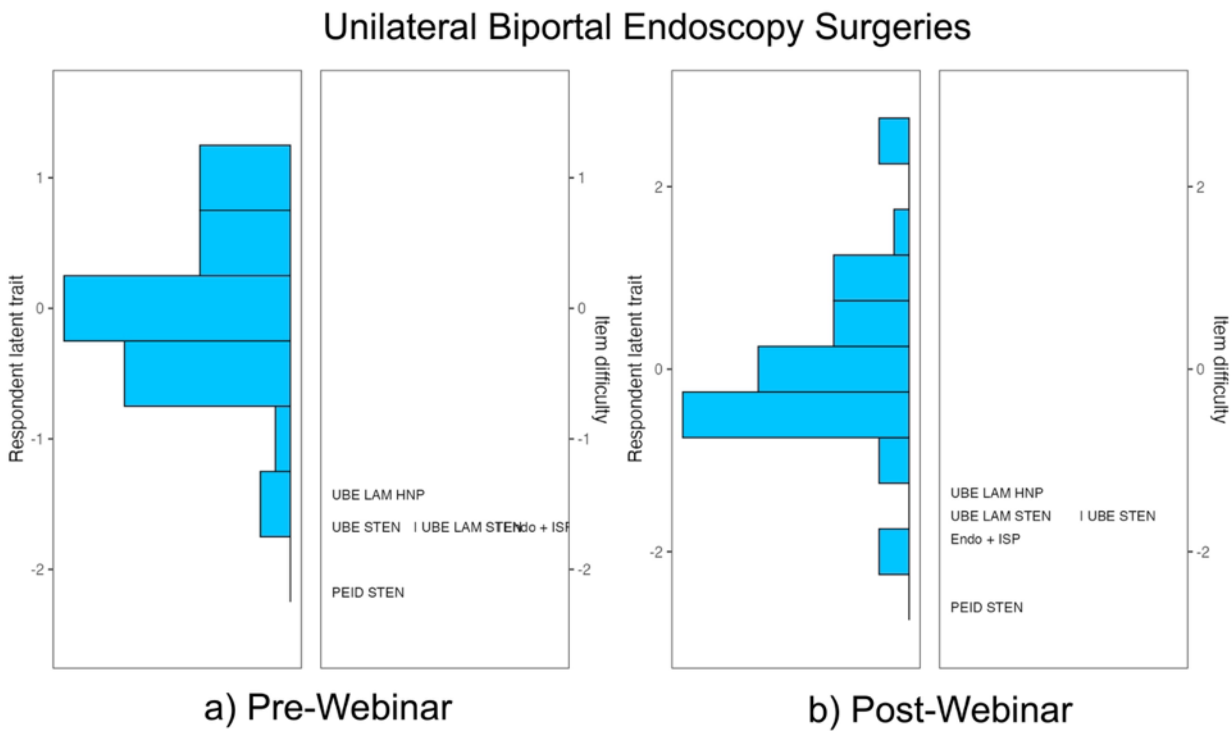

Figure 8. Wright plot obtained in the polytomous Rasch analysis of prewebinar (left panel) and postwebinar (right panel) survey responses. The item response theory polytomous Rasch partial agreement analysis was employed to assess spine surgeons' level of endorsement of the 5 procedures (test items) presented during the webinar: (a) unilateral biportal endoscopic (UBE) laminectomy for central stenosis (UBE LAM STEN), (b) UBE laminectomy for herniated disc (UBE LAM HNP), (c) UBE decompression for lateral canal stenosis (UBE STEN), (d) percutaneous interlaminar endoscopic decompression for lateral canal stenosis (PEID, and (e) transforaminal endoscopic decompression with simultaneous interspinous process spacer for lateral canal stenosis (Endo + ISP). On the left side of the Wright plot, the responding surgeons' latent traits are written in logits (log odds) as estimates of true intervals of item difficulty and surgeon ability or this study experience-based endorsements. The surgeons, represented by horizontal bars at the top, indicated a higher level of endorsement for the individual test components of endoscopic spinal surgery (positive logits) than those on the bottom (negative logits). On the right, the higher-level endorsement items are listed at the top vs the more controversial ones on the bottom. Directly across from 0, those surgeons had a 50% chance of endorsing a test item. One logit above suggests an approximately 25% chance that the test item was endorsed vs one logit below suggesting an approximately 75% chance of endorsement. There were no assessment gaps in the prewebinar survey but 2 in the postwebinar survey. Prewebinar survey analysis showed the log-ranking for UBE STEN, UBE LAM STEN, and Endo + ISP with similar locations in the Wright plot, suggesting that there was some redundancy between test items, and surgeons had difficulty discriminating them based on the survey questions. In the postwebinar survey, the items UBE LAM HNP, UBE LAM STEN, and UBE STEN were the most challenging to agree on. After the webinar, surgeons agreed more readily with the information presented on test item Endo + ISP. The item PEID was the easiest to agree on both before and after the webinar, suggesting wide acceptance of PEID among endoscopic spine surgeons in the treatment of lateral canal stenosis and HNP.

all procedural test items were challenging to agree upon based on the wide disorderly spread. Postwebinar, the intensity of agreement was still disorderly, except for PEID, which increased as demonstrated by the logit locations having shifted to the right. The clinical evidence presented in these item presentations during the webinar was convincing to the webinar participants, but most noticeably for PEID.

Fit and DIF Bias Statistics

Infit and outfit statistics showed that all calculated values were between 0.6 and 1.4 before and after the webinar, suggesting that both the outlier-sensitive statistics (outfit) and the inlier-sensitive or information-weighted fit statistics, which are more sensitive to the pattern of responses to items targeted on the person, fit the Rasch model well (Tables 1 and 2), suggesting lack of distortion in the data due to bias. The authors also employed the MAPQ3 methodology rooted in IRT analysis with 0.204 ($P < 0.005$) calculated for the prewebinar survey and 0. 284 ($P < 0.001$) for the postwebinar survey—less than 0.3 corroborating the absence of data distortion. The DIF statistics for the prewebinar survey DIF detection procedure showed no statistically significant difference between orthopedic (reference group) and neurosurgeons (focal group; Table 3) in the item response characteristics curve (Figure 10), again suggesting the absence of data distortion due to bias. The postwebinar DIF statistics showed a statistically significant difference only for the item "unilateral biportal endoscopic laminectomy for central stenosis UBE LAM STEN," indicating data distortion suggestive of bias for this test item in the postwebinar survey (Table 4 and Figure 11).

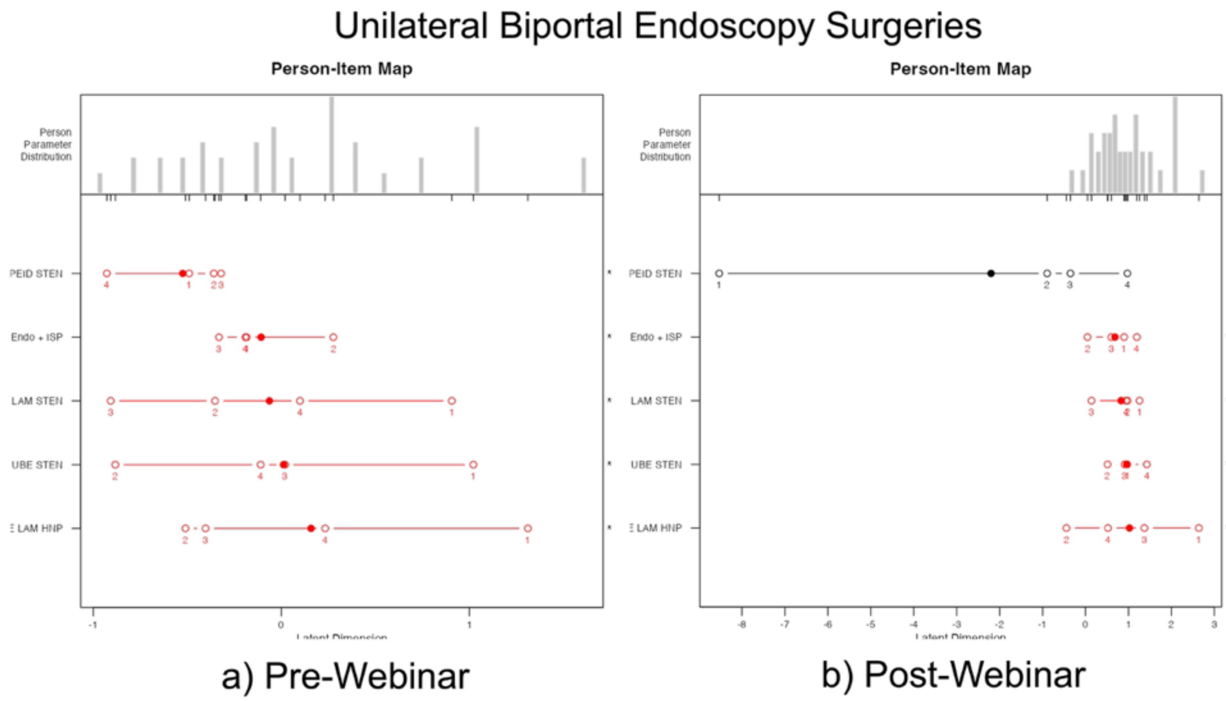

Figure 9. The person-item map of postwebinar survey responses shows the logarithmically transformed person and item positions on a unified continuum using the logit measurement unit, transitioning ordinal data to equal-interval data. This method charts both person and item positions (in logits) along the x axis (labeled "Latent Dimension"). Within Rasch modeling, these values are labeled as "locations" rather than "scores." A surgeon's logit location indicates their natural log odds of agreement with a series of items. Individuals with pronounced adherence to the considered attitude affirm items favorably, positioning them further to the right on the scale. The solid dots indicate the mean person location scores. Disordered items are shown in red and ordered ones in black. Examining the order and location of these test items reveals an uneven distribution of the ranked order of item difficulties or intensities along the logit continuum suggesting a poor fit to the Rasch model without any statistically significant difference between the observed values and the values predicted by the model suggesting that surgeons had difficulty consistently discriminating between response categories ranging from strongly disagree (1), disagree (2), agree (3), and to strongly agree (4)—a problem observed when there are too many response options not measuring the opinions. In comparison to the descriptive statistical prewebinar analysis (Figure 2), all procedural test items including (a) unilateral biportal endoscopic (UBE) laminectomy for central stenosis (UBE LAM STEN), (b) UBE laminectomy for herniated disc (UBE LAM HNP), (c) UBE decompression for lateral canal stenosis (UBE STEN), (d) percutaneous interlaminar endoscopic decompression for lateral canal stenosis (PEID), and (e) transforaminal endoscopic decompression with simultaneous interspinous process spacer for lateral canal stenosis (Endo + ISP) were challenging to agree upon based on the wide disorderly spread. After the webinar (descriptive statistics shown in Figure 3), the intensity of agreement, still disorderly except for PEID, increased as demonstrated by the logit locations having shifted to the right. The clinical evidence presented in these item presentations during the webinar was convincing to the webinar participants but most noticeably for PEID. The person-item maps on top of the graph also illustrate distribution gaps in the prewebinar analysis and normal distribution in the postwebinar analysis.

Table 1. Prewebinar survey model fit analysis and item statistics of the rating scale model.

Procedure	Measure	SE Measure	Infit[a]	Outfit[b]
UBE STEN	−1.35	0.114	1.087	1.025
PEID	−2.04	0.127	0.989	0.994
UBE LAM STEN	−1.74	0.116	0.982	0.915
UBE LAM HNP	−1.51	0.113	0.936	0.962
Endo + ISP	−1.69	0.115	1.093	1.117
		Person Reliability	**MADaQ3**	***P***
Scale		0.526	0.204	0.005

Abbreviations: Endo + ISP, transforaminal endoscopic decompression with simultaneous interspinous process spacer for lateral canal stenosis; MADaQ3, mean of absolute values of centered Q_3 statistic with *P* value obtained by Holm adjustment; PEID, percutaneous interlaminar endoscopic decompression for lateral canal stenosis; UBE LAM HNP, unilateral biportal endoscopic laminectomy for herniated disc; UBE LAM STEN, unilateral biportal endoscopic laminectomy for central stenosis; UBE STEN, unilateral biportal endoscopic decompression for lateral canal stenosis.
[a]Information-weighted mean square statistic.
[b]Outlier-sensitive mean square statistic.

Table 2. Postwebinar survey model fit analysis and item statistics of the rating scale model.

Procedure	Measure	SE Measure	Infit[a]	Outfit[b]
UBE STEN	−1.57	0.131	0.744	0.687
PEID	−2.48	0.162	0.868	0.948
UBE LAM STEN	−1.69	0.131	0.895	0.813
UBE LAM HNP	−1.47	0.131	1.092	1.058
Endo + ISP	−1.85	0.134	1.343	1.343
		Person Reliability	**MADaQ3**	***P***
Scale		0.655	0.284	<0.001

Abbreviations: Endo + ISP, transforaminal endoscopic decompression with simultaneous interspinous process spacer for lateral canal stenosis; MADaQ3, mean of absolute values of centered Q_3 statistic with *P* value obtained by Holm adjustment; PEID, percutaneous interlaminar endoscopic decompression for lateral canal stenosis; UBE LAM HNP, unilateral biportal endoscopic laminectomy for herniated disc; UBE LAM STEN, unilateral biportal endoscopic laminectomy for central stenosis; UBE STEN, unilateral biportal endoscopic decompression for lateral canal stenosis.
[a]Information-weighted mean square statistic.
[b]Outlier-sensitive mean square statistic.

Table 3. Prewebinar survey DIF detection procedure for ordinal data based on adjacent category logit model: likelihood ratio using χ^2 analysis.

Procedure	Statistic[a]	*P*	Adjusted *P*
UBE STEN	1.177	0.555	0.818
PEID	3.651	0.161	0.806
UBE LAM HNP	0.848	0.654	0.818
UBE LAM STEN	0.312	0.856	0.856
Endo + ISP	1.027	0.598	0.818

Abbreviations: DIF, differential item functioning; Endo + ISP, transforaminal endoscopic decompression with simultaneous interspinous process spacer for lateral canal stenosis; PEID STEN, percutaneous interlaminar endoscopic decompression for lateral canal stenosis; UBE LAM HNP, unilateral biportal endoscopic laminectomy for herniated disc; UBE LAM STEN, unilateral biportal endoscopic laminectomy for central stenosis; UBE STEN, unilateral biportal endoscopic decompression for lateral canal stenosis.
Note. The adjusted *P* values were adjusted by likelihood ratio test using multiple comparison.
[a]DIF likelihood ratio statistics are estimated by using difNLR and difORD function.

Table 4. Postwebinar survey DIF detection procedure for ordinal data based on adjacent category logit model: likelihood ratio χ^2 statistics.

Procedure	Statistic[a]	*P*	Adjusted *P*
UBE STEN	1.9706	0.373	0.906
PEID	0.0565	0.972	0.972
UBE LAM HNP	0.7903	0.674	0.906
UBE LAM STEN	16.2144	<0.001	0.002
Endo + ISP	0.6434	0.725	0.906

Abbreviations: DIF, differential item functioning; Endo + ISP, transforaminal endoscopic decompression with simultaneous interspinous process spacer for lateral canal stenosis; PEID, percutaneous interlaminar endoscopic decompression for lateral canal stenosis; UBE LAM HNP, unilateral biportal endoscopic laminectomy for herniated disc; UBE LAM STEN, unilateral biportal endoscopic laminectomy for central stenosis; UBE STEN, unilateral biportal endoscopic decompression for lateral canal stenosis.
Note. The adjusted *P* values were adjusted by likelihood ratio test using multiple comparison.
[a]DIF likelihood ratio statistics are estimated by using difNLR and difORD function.

DISCUSSION

The ISASS webinar series "Current and Emerging Techniques in Endoscopic Spine Surgery" underscores the growing interest and current practice trends in endoscopic spine surgery. The second webinar out of a series 4 has significantly influenced the perceptions of requirements to master the learning curve and endorsements of spine surgeons regarding several different versions of the UBE for central and lateral canal stenosis in comparison to the PEID and the transforaminal decompression in combination with an ISP. With significant

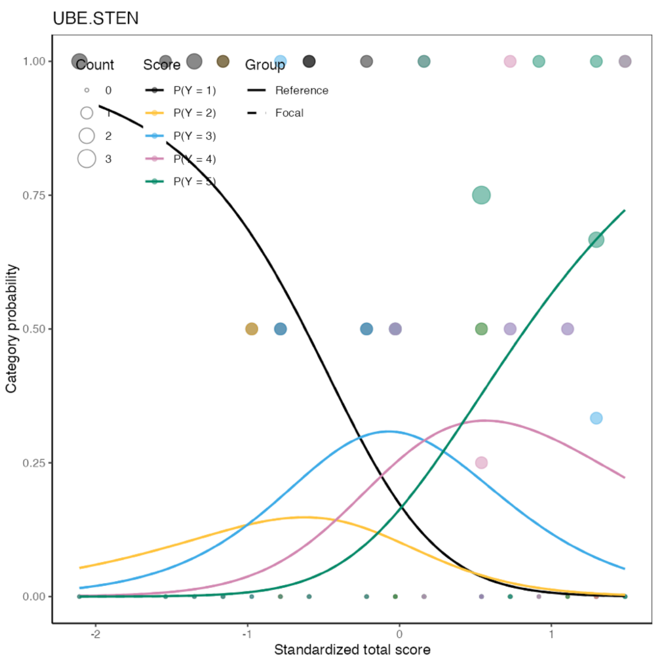

Figure 10. A sample item characteristic curves generated from prewebinar survey responses for unilateral biportal endoscopic decompression for lateral canal stenosis as part of a differential item functioning (DIF) detection process to detect item bias between orthopedic and neurosurgeons using the difNLR() and difORD() functions. Specifically, when DIF is identified in an item, 2 distinct curves are generated: one for the reference group (orthopedic surgeons) and another for the focal group (neurosurgeons). Alongside these curves, empirical probabilities are visualized as points, which indicate the proportion of correct responses relative to the participant's ability level and group. The size of these points reflects the number of respondents at each ability level, which showed no significant difference between orthopedic (reference group) and neurosurgeons (focal group) with the statistics for DIF detection of 1.177 and a *P* value of 0.555 (Table 3). There were no displayable differences between orthopedic and neurosurgeons.

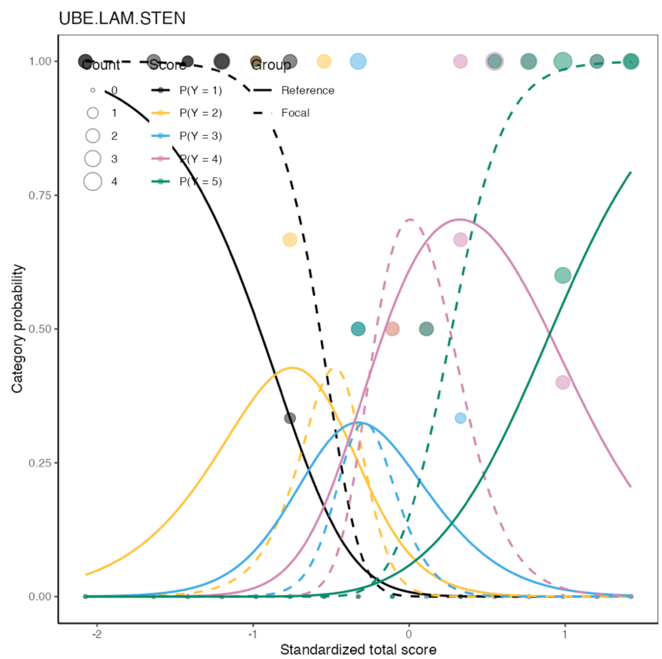

Figure 11. A sample item characteristic curves generated from postwebinar survey responses unilateral biportal endoscopic laminectomy for central stenosis (UBE LAM STEN) as part of a differential item functioning (DIF) detection process to detect item bias between orthopedic and neurosurgeons using the difNLR() and difORD() functions. Specifically, when DIF is identified in an item, 2 distinct curves are generated: one for the reference group (orthopedic surgeons—solid lines) and another for the focal group (neurosurgeons—dashed lines). Alongside these curves, empirical probabilities are visualized as points, which indicate the proportion of correct responses relative to the participant's ability level and group. The size of these points reflects the number of respondents at each ability level, which showed a significant difference between orthopedic surgeons (reference group) and neurosurgeons (focal group) with the statistics for DIF detection of 16.2144 and a *P* value of <0.001 (Table 4), suggesting bias in the test item.

online attendance and active participation in pre- and postwebinar surveys, the survey completion rates significantly increased from 50.0% prewebinar to 74.3% postwebinar, reflecting a heightened surgeon engagement. The representation across different specialties and experience levels suggests a broad-based interest in endoscopic spine surgery techniques, with a notable predominance of orthopedic surgeons over neurosurgeons.

Descriptive Opinion Statistics

Analysis of the learning curve assessments reveals a consensus on the existence of a learning curve in mastering endoscopic spine surgery, with slight variations in the estimated number of cases required for proficiency. During the webinar, 70 to 100 cases were discussed as a reasonable number to master the learning curve. Webinar participants in the pre- and postwebinar survey put that number under 20. The average number of years in practice ranged between 17 and 18 years. The high number of clinical practice experiences in the pre- and postwebinar survey seems to be a practical explanation of why mentorship and cadaver exceeded other learning opportunities as these 2 mechanisms were likely more familiar and, hence, psychometrically measurable for those early adopters who started as autodidacts. This observation may also reflect the emergence of endoscopic technology, which has not entirely been made available to postgraduate residents and fellow trainees. The polytomous Rasch analysis further illuminated the nuanced perceptions of surgeons regarding various endoscopic procedures' learning methods. The clear preference for mentorship and cadaver courses as essential components in overcoming the learning curve aligns with the broader shift in medical education toward experiential learning. The consistency in ranking these learning methods, both before and after the webinar, as illustrated in the person-item maps, underscores their perceived relevance and utility to practicing spine surgeons.

Rasch Survey Analysis

Utilizing the polytomous Rasch model for analyzing surgeon endorsements provided a unique insight into how education and exposure to advanced techniques can shift professional confidence and acceptance of innovative training methods and surgical approaches. The emphasis on cadaver courses and mentorship, particularly the shift toward the latter in the postwebinar survey, highlights an evolving preference for more interactive and personalized learning experiences over traditional autodidactic or formalized educational programs. These observations suggest a trend toward valuing real-world, hands-on experience and expert guidance in the complex skill acquisition of endoscopic techniques.

The postwebinar increase in confidence levels in performing specific endoscopic procedures, especially those involving lateral canal stenosis employing the PEID procedure, reflects the webinar's effectiveness in identifying a widely accepted endoscopic lumbar lateral canal decompression surgery while enhancing participants' clinical knowledge and procedural confidence. The widespread acceptance of percutaneous endoscopic interlaminar decompression for lateral canal stenosis before and after the webinar signifies a general agreement on its efficacy. The combination of transforaminal decompression with interspinous process stabilizers continued to be a source of disagreements, implying that the 2 technologies did not go together, and the indication remained unclear to webinar participants. However, the subtle rise in endorsements for combining the transforaminal endoscopic decompression with interspinous process spacer placement indicates a shift toward more integrative approaches to spine surgery, potentially offering better outcomes for patients with posterior column stabilization. Spine surgeons appear to be interested in how to solve more complex problems with the endoscopic surgery platform.

Most of the survey questions' (items) categories did discriminate well, and the observed data did follow the predictions by the Rasch model well, with most of the outfits just below 1. Outfit statistics of less than 1 would suggest that the data are less variable than what the Rasch model expects—they would have been "overpredictable." This observation could indicate redundancy among items (eg, 2 questions that were too similar to each other), or some items are not contributing useful information for distinguishing among respondents. Essentially, it could imply that some survey questions were too easy and did not add value to the measurement process. While values close to 1.0 are ideal, typically values in the range of 0.7 to 1.3 ares considered indicative of good fit. However, very low outfit values were not observed. If so, they would generally be less concerning than high values, as they do not indicate noise caused by outliers. The observed infit and outfit values suggested that author's survey instrument's questions displayed good efficiency without prior calibration or refinement that could have been dictated by having to address redundant or overly predictable items.

Many of the test items generated disordered responses as displayed in the person-item maps. Using the UBE surgeries as an example, the authors learned that the UBE procedures, regardless of whether they were intended to treat the central or lateral canal, generated high-intensity disagreements and agreements with disordered responses. Such observations are often caused by category overlap or reversal, indicating that respondents might have found distinguishing between certain levels of agreement or endorsement challenging. Disordered responses with high intensity for disagreement and agreement indicate a strong polarization in opinions. When the expected order of response categories does not progress in a clear, linear manner, it is often caused by confusion due to ambiguity in the response categories or the item potentially being too complex, leading respondents to interpret it in varied ways. Another possible explanation is the lack of scale sensitivity to capture nuanced differences in respondents' attitudes or perceptions, leading to unexpected jumps or reversals in category use. In practical terms, disordered responses should necessitate a closer examination of the UBE procedures in the future to define better survey items and a more appropriate response scale to revise the UBE items for clarity. In comparison to the transforaminal and interlaminar technique, which have been in clinical practice well over 30 years, the UBE procedures are still relatively new, with the first reports of its contemporary application having been published almost 10 years ago.[14] Therefore, surgeons' perceptions about UBE are likely less solidified and generated polarized responses. Another plausible explanation for the UBE observations is that many surgeons had varied clinical experience with the emerging UBE endoscopic surgery platform employed for 3 different surgical indications, thereby obviating an orderly response at a high-intensity level. It is the authors expectation that future investigations will likely uncover endorsement shifts as the technology gains further clinical acceptance.

Limitations

Besides the apparent limitations discussed thus far, including potentially high item complexity and lack of scale sensitivity, other perceived limitations may appear relevant to the reader who is unfamiliar with the Rasch methodology. One might argue that there could have been many forms of bias swaying surgeon responses and the sample size was too small. The authors managed to exceed the suggested minimum of 30 survey participants to yield statistically stable measures (within ±1.0 logits at a 95% confidence level).[11] The criterion of bias may be divided into external or internal. Several statistical techniques have been investigated to detect bias, including regression and ANOVA, besides Rasch analysis. Linear regression analysis of residuals considers a test biased if the regression slopes for different groups are significantly different, meaning that the relationship between the predictor (test score) and the criterion (the outcome or actual score) differs across groups, indicating that the test does not predict outcomes equally well for all groups. Bias is also present if regression intercepts for different groups are significantly different, suggesting that, even with the same score on the predictor, expected outcomes differ across groups, indicating a systematic advantage or disadvantage for specific groups. ANOVA can detect bias in a test by comparing the mean scores of different groups on a particular measure. The basic principle behind ANOVA is to analyze the variance within each group and compare it to the variance between groups. If the test is unbiased, one would expect that any significant differences in mean scores are due to chance or factors unrelated to the test's intended measurement. Regression and ANOVA are flawed if they are based on an external criterion that relies on the assumption that the criterion is an unbiased measure. The difficulty of constructing an unbiased criterion calls for using only an internal criterion and, hence, only the information contained in the responses of persons to test items. The Rasch logistic response model can meet these requirements. It primarily uses internal criteria to evaluate and measure responses to items within a test or survey.

Bias Detection

The Rasch logistic response model—a form of IRT modeling—focuses on the relationship between individuals' abilities (or trait levels) and the difficulty of items within a measurement instrument. Therefore, the application of Rasch analysis frees the comparison of item difficulties across groups from differences in the distribution of person ability within groups. It specifies a logistic transformation of the traditional item difficulties as the only reasonable transformation. The variance of item difficulty estimates now corresponds to the real situation in which information is maximum in the center and minimum at the extremes. The maximum likelihood estimation techniques applicable to the model lead to useful asymptotic estimates of the variance of parameter estimates. All this makes it possible to identify tests that are biased in ways that do not change the relative difficulties of items but rather their scale of measurement, to separate biased items from items that misfit for other reasons, and to specify the magnitude of residual variance to be expected when items and persons together fit the measurement model. Therefore, the authors' observations regarding surgeon responses can be considered a largely unbiased representation of current trends. Only one test item, UBE LAM STEM, suffered from some data distortion in the postwebinar survey suggestive of bias (Table 4 and Figure 11).

CONCLUSIONS

The ISASS webinar series has played a pivotal role in shaping surgeons' perspectives on the learning curve and efficacy of UBE and PEID endoscopic spine surgery techniques. The analyses underscore the critical role of practical, hands-on training methods, such as cadaver courses and mentorship, in overcoming the learning curve. Furthermore, the webinar has improved surgeons' confidence in the presented lumbar endoscopic surgery techniques, corroborating the existing consensus regarding the PEID technique and a trend toward endoscopic surgeries capable of addressing more complex spinal pathologies requiring wider decompressions and stabilization of the spine with less invasive techniques—the UBE techniques and the combination of endoscopic decompression with simultaneous placement of an ISP being such examples. The polytomous Rasch analysis of partial procedural endorsements illustrated the ongoing dynamic shifts in preferences and consensus on best practices in endoscopic spine care. The key takeaways from the second webinar's surveys and analyses underscore the importance of mentorship, practical experience, and wide acceptance of the PEID for lateral canal stenosis decompression.

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Corresponding Author: Kai-Uwe Lewandrowski, Division Personalized Pain Research and Education, Center for Advanced Spine Care of Southern Arizona, 4787 E Camp Lowell Dr, Tucson, AZ 85712, USA; business@tucsonspine.com

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