Implementation of an Intraoperative Instructional Timeout Just Prior to Stapler Use Improves Proficiency of Surgical Stapler Usage by Surgery Residents

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INTRODUCTION: With the fragmented rotational structure of training, exposure to surgical staplers is not uniform across surgical residents. Traditionally, educational sessions dedicated to instruction in surgical staplers have taken place outside the operating room. This study implemented and evaluated an intraoperative timeout immediately prior to stapler use in cases with surgical residents.

METHODS: During general surgery cases from June 1, 2017 until December 31, 2017, surgical teams, including the surgical attending, surgical resident, and scrub nurse participated in an intraoperative instructional timeout, during which proper use of linear or circular staplers was reviewed. At the conclusion of the timeout, residents were required to demonstrate proper stapler assembly and verbalize all technical steps involved in stapler use. Duration of each timeout was recorded. Immediately following the case, a pre-post survey was administered to each participating junior (R1-R2) or senior (R4-R5) surgical resident. The primary outcome was change in stapler use knowledge by surgical residents. Survey questions with Likert scale responses were analyzed using paired *t*tests, and responses from junior residents were compared to those from senior residents with independent *t* tests.

RESULTS: Forty-three general surgery cases involved stapler use during the study period and implemented an intraoperative instructional timeout. The educational intervention increased stapler use knowledge significantly in all surgical residents. Prior to the timeout, junior residents reported significantly higher anxiety related to stapler usage compared to their senior counterparts; anxiety scores in junior residents decreased significantly for use of both linear and circular staplers. The mean timeout duration was 2.9 minutes (standard deviation 0.9 minutes, range 1.2-4.6 minutes). All participating surgical residents recommended routine implementation of an instructional timeout prior to intraoperative stapler use.

CONCLUSIONS: An intraoperative timeout dedicated to stapler teaching is effective in increasing proficiency and easing anxiety in all levels of surgical residents. Further research is warranted to determine whether this educational intervention would translate into fewer stapler use errors and decreased intraoperative complications. (J Surg Ed 76:1622−1628. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: surgical education, interprofessional education model, surgical stapler, resident education, timeout

COMPETENCIES: Interpersonal and Communication Skills, Practice-Based Learning and Improvement, Systems-Based Practice

INTRODUCTION

The use of surgical staplers results in 8000 to 9000 reported complications every year in the United States, according to the US Food and Drug Administration.[1] The majority of the complications occurred during gastrointestinal surgeries (65%).[2]

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  1931-7204/$30.00 https://doi.org/10.1016/j.jsurg.2019.05.005

The most frequently reported stapler problems are lack of staple line formation, stapler misfire or failure to fire, and separation of suture lines. While the most frequently reported patient problems due to stapler malfunction are anastomosis failure, prolonged surgery, bleeding, and infection. Death is reported in less than 1% of cases.[1]

There is a multitude of potential causes leading to surgical stapler-related complications. They are often multifactorial and include flaws in technology, design, usability, reliability, maintenance, supplies, and procurement. Additionally, operator error including stapler selection, preuse checks, or improper use can also result in stapler related complications.[3] Given the negative impact of surgical stapler user errors on patient's health and safety, it is the surgeon's responsibility to remain proficient in the stapling instruments they use.

The stapling devices used for creating gastrointestinal anastomoses are in a continued developmental evolution marked by the introduction of new staplers and technical improvements in existing devices. An unintended consequence of these rapid technological advances is a gap in surgeon's knowledge of newer-generation surgical staplers.[4]

While this device knowledge gap can affect all practicing surgeons, it represents a particularly significant challenge for surgical residents. Due to the fragmented, rotational structure of surgical resident training, consistent education, and frequent exposure to updated stapler technology is less likely to occur. Not surprisingly, stapler deployment by surgery residents is associated with a user error rate as high as 19%.[5]

Because of this stark trend, surgical educators have employed a variety of out-of-operating-room instructional sessions[6] and simulation-based techniques[7,8] for training residents in surgical staplers. However, focused didactic-based medical education has been shown to be less efficient than experiential learning (simulation) for clinical knowledge retention.[9]

While simulation-based education improves surgical skill acquisition, retention of the skills is not guaranteed. Furthermore, studies have shown that skill deterioration occurs soon after simulation training in general surgery.[10-13] Although simulation-based teaching has become a well-established educational tool, it has also proved to be more resource intensive due to simulator acquisition, maintenance costs, and significant time for teachers to be trained in simulator use to effectively deliver the simulated intervention.[14]

We propose the novel alternative of a live, intraoperative instructional timeout just prior to stapler use by surgery residents. To our knowledge, this has not been trialed or studied previously and may serve as an efficient and economical solution to minimize stapler related complications in the operation room.

METHODS

An instructional stapler timeout was implemented just before linear and circular stapler use in general surgeries from June 1, 2017 until December 31, 2017. The study group included general surgery residents in year 1 or 2 (junior residents, R1-R2) of their training and in year 4 or 5 (senior residents, R4-R5) rotating at the Boston VA Healthcare System/West Roxbury Campus from Boston Medical Center and Brigham and Women's Hospital. Each resident was surveyed only once per type of stapler (circular and/or linear stapler).

The instructional stapler timeout involved the surgical attending, resident, and surgical technologist who together reviewed the proper stapler selection (staple height, cartridge color for linear staplers; staple diameter, and shaft length for circular staplers), preparation (loading cartridge and removing staple retaining cap for linear staplers; disconnecting the anvil and purse-string formation for circular stapler), and deployment. The review effectively served as an ad-hoc orientation to surgical staplers just prior to their actual use in patients. At completion of the timeout, residents were required to demonstrate proper stapler selection, preparation, and verbalize all steps of stapler deployment. The duration of each timeout was recorded.

Following the surgery, a retrospective pre-post survey comprised of 5 ranked questions (utilizing a 5-point Likert Scale) and 3 binary questions (with Yes/No answer) were administered to the participating residents. Only 100% completed questionnaires that were completed <6 hours after operations were included and analyzed.

The 5 ranked questions assessed both the resident anxiety related to stapler use (2 questions) and their knowledge and skills on selecting, preparing, and using the linear and circular stapler (3 questions). Numeric scores from 1 (least favorable) to 5 (most favorable) were assigned to each response. Cumulative scores were then compiled for both categories.

The short-answer and binary questions addressed the resident opinion on whether the time-out increases intraoperative safety and improves the communication in the operation room. Residents were also asked if they would recommend the routine implementation of a time-out prior to any stapler and device use.

All data were collected in accordance with the requirements of our Institutional Review Board. Completion of the survey was voluntary and anonymity was ensured. Statistical analysis was performed by a data analyst who was blinded to the timing of the survey (pre- or post-timeout), the training level of the surgical residents, and the type of stapler used. Data were analyzed with SAS statistical software by parametric or nonparametric analysis as appropriate. Comparisons between pre- and post-timeout scores were performed using paired *t* tests. The differences between the R1-

R2 and R4-R5 residents were examined using independent *t* tests. $p < 0.05$ was considered statistically significant.

RESULTS

A total of 34 general surgery residents (14 R1, 11 R2, 5 R4, and 4 R5) participated in the study. There were 20 residents (11 R1, 5 R2, and 4 R5) from the Boston Medical Center and 14 residents (3 R1, 6 R2, and 5 R4) from the Brigham and Women's hospital. Females represented 44% (15 out of 34) of the residents.

As shown in Table 1, of a total of 43 surveys were conducted by 34 general surgery residents. Of the 43 surveys, 58.1% (25 out of 43) were completed by junior (R1-R2) residents after the use of 14 linear and 11 circular staplers. Senior (R4-R5) residents completed 41.9% (18 out of 43) of the surveys after using 9 linear and 9 circular staplers.

Figures 1 and 2 depict the junior and senior resident pre- and post-timeout anxiety scores associated with the use of linear and circular staplers, respectively. Mean pretimeout anxiety scores for both staplers were significantly higher in R1-R2 vs R4-R5 residents ($p < 0.001$). Senior residents (R4-R5) were significantly more anxious about the use of circular vs linear stapler ($p = 0.02$). Timeout statistically improved linear stapler anxiety scores in the R1-R2 ($Mean_{Difference} = -4.00$; $p < 0.001$) but not in the R4-R5 group ($p = 0.05$). When compared to pretimeout, anxiety scores after the use of a circular stapler, anxiety significantly improved in both R1-R2 ($Mean_{Difference} = -5.55$; $p < 0.001$) and R4-R5 residents ($Mean_{Difference} = -2.89$; $p = 0.01$).

Figures 3 and 4 illustrate the junior and senior resident pre- and post-timeout scores of linear and circular stapler knowledge, respectively. Mean pretimeout knowledge scores for both staplers were significantly higher in the R4-R5 vs R1-R2 group ($p < 0.001$). Timeout significantly improved knowledge scores for both linear ($Mean_{Difference} = 9.00$; $p < 0.001$) and circular stapler ($Mean_{Difference} = 11.18$; $p < 0.001$) in R1-R2 residents.

In R4-R5 residents, while the post-timeout knowledge scores significantly increased for both staplers, this effect was more pronounced for the circular stapler ($Mean_{Difference} = 5.00$; $p = 0.001$) then for the linear stapler ($Mean_{Difference} = 1.33$; $p = 0.04$).

The average timeout duration was 2.9 ± 0.9 minutes (range of 1.2-4.6). As shown in Table 2, the duration of timeout for both linear and circular staplers was significantly longer for the R1-R2 vs R4-R5 residents ($p < 0.001$). For both junior and senior residents, the timeout for the circular stapler was significantly longer than for the linear stapler ($p \leq 0.001$).

There were no differences in scores based on who was the attending surgeon or the surgical technologist participating in the operation. The type of surgery performed did not influence scores.

All 7 participating attending surgeons reported in feedback that the additional timeout was of benefit in terms of education and minimizing stapler technique errors. There were no stapler-related complications during surgeries where a timeout was implemented.

The answers to the binary questions demonstrated that all participating residents would recommend the routine implementation of a time-out prior to any stapler and device use. They believe that in addition to improving their stapler proficiency, the timeout increases intraoperative safety and improves the communication in the operation room.

In their optional written comments 59% (20 out of 34) residents indicated that this educational intervention was a "great" and "exciting" learning opportunity.

DISCUSSION

Our results demonstrate that increased exposure and instruction to various linear and circular staplers result in increased knowledge about proper stapler use and higher comfort levels with the use of surgical staplers. Increased familiarity and comfort with staplers lead to improved outcomes by minimizing poor technique and common errors encountered with stapler use. This is consistent with current literature that finds a direct correlation between experience and functionality of the surgeon with adverse outcomes related to intraoperative stapler use.[3-5]

Unlike previous studies identifying causes of stapler related adverse events, we developed a unique timed approach to simultaneously provide both a safety stop as well as a brief educational opportunity prior to proceeding with a critical phase of the operation.

The utilization of this surgical stapler time out was implemented for residents for all levels of training with consistent reduction of anxiety and improved knowledge across all experience levels. Interestingly, senior residents reported more anxiety related to circular staplers as compared to linear staplers. This is likely explained by more frequent exposure to linear staplers early in their training leading to greater familiarity. This directly supports our findings that increased education and hands-on experience improves a surgical trainee's performance with staplers. Additionally, this time out does not significantly lengthen the time of the procedure and on average was performed in less than 3 minutes, proving its utility in all operations.

Surgical stapler time outs involving the attending surgeon, surgical technician, and surgical resident represent an interprofessional education model that provides a

TABLE 1. Number of Surveys According to Resident Level of Training and Type of Stapler Used

	R1-R2 Surveys	R4-R5 Surveys
Linear stapler	14	9
Circular stapler	11	9

unique opportunity for improving teamwork. Interprofessional education in health care occurs when 2 or more professions learn about from, and with each other in order to improve their knowledge, enable effective collaboration, and ultimately improve patient outcomes.[15,16]

While we demonstrated that our innovative teaching model would be useful for skill acquisition, it also has a great potential for retaining the acquired skills. The simplicity, resource neutrality, and the nondisruptive nature are significant advantages that would allow our feasible model to be used for frequent practicing and repetition which are crucial for skill retention. With estimations of surgical staples being used in more than 100,000 surgeries each year in the United States,[1] there is great potential for frequent use of instructional timeouts prior to stapler use. One of the limitations of this study is the single timepoint of data collection. Future studies will collect the resident's intraoperative performance longitudinally to further describe the retention of skills learned during our intervention. Another limitation is the small sample size that may limit the ability to generalize our portrayed findings. However, the total number of participating residents in our study is well within the range of sample sizes for other resident education studies in the surgical literature.

Although we analyzed questionnaires that were completed within a short time frame (<6 hours) after operations, recall bias remains a limitation of our retrospective pre-post survey. However, the retrospective pre-post design is convenient as collecting both post-test and pretest perceptions of respondents at the same time is less burdensome and intrusive for the residents. The use of a retrospective pre-post survey allowed us to study our educational intervention even in cases when the use of staplers was not anticipated preoperatively.

Furthermore, retrospective pre-post survey can reduce or eliminate response shift bias,[17,18] which occurs when respondents recalibrate their internal frame of reference between the pretest and the post-test due to the influence of the educational intervention.

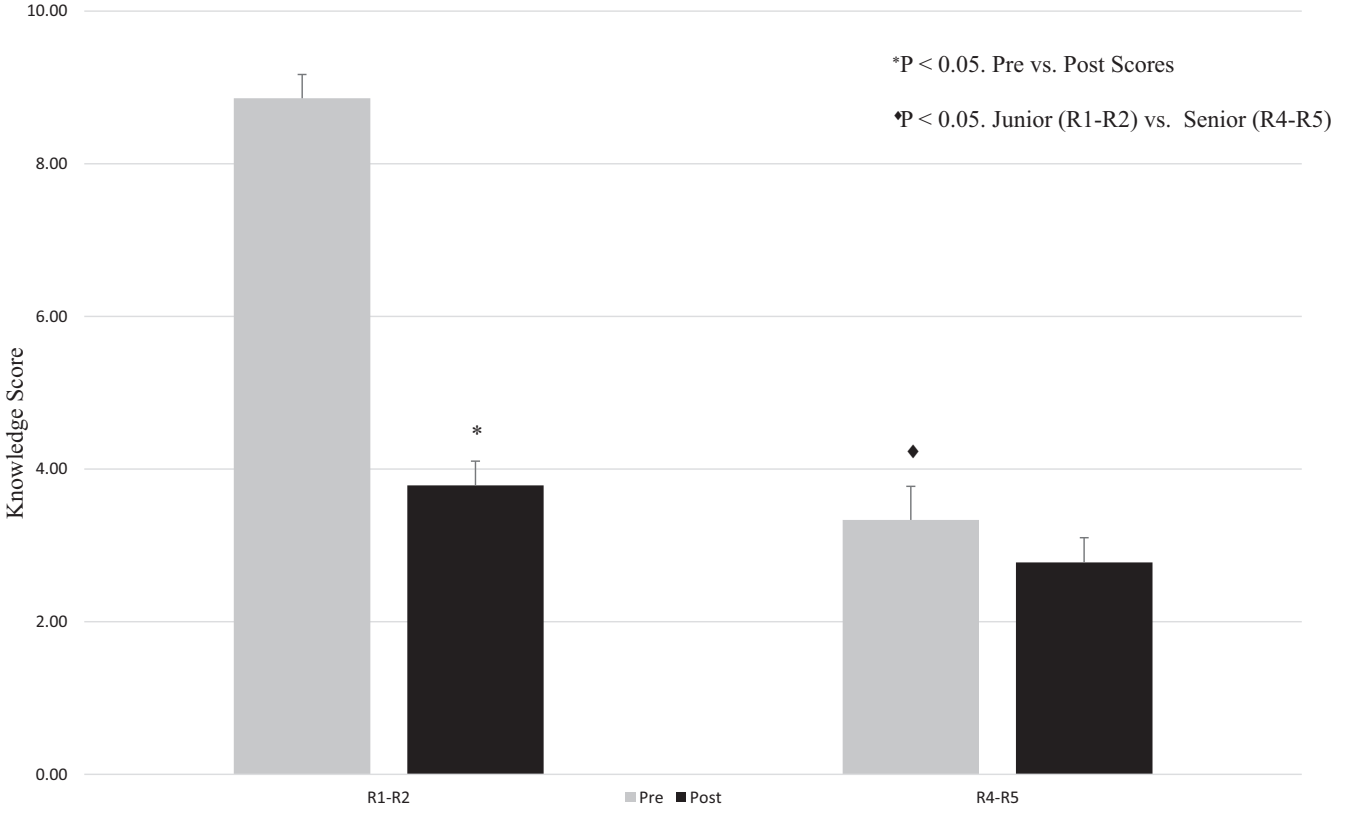

FIGURE 1. Linear stapler anxiety scores pre- and post-timeout (mean ± SEM).
(Maximum knowledge score of 15 is obtained from 5-point Likert summed across the 3 questions for knowledge.)

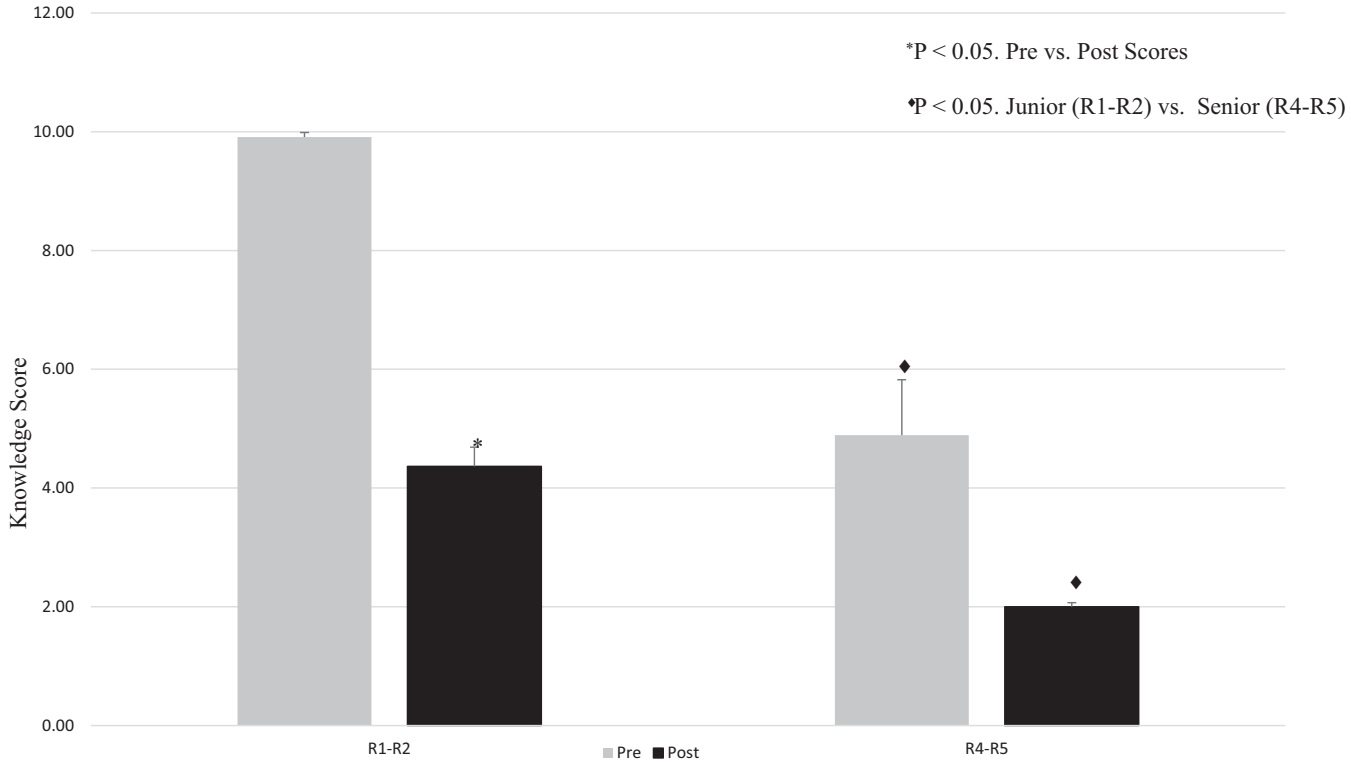

FIGURE 2. Circular stapler anxiety scores pre- and post-timeout (mean ± SEM).
(Maximum knowledge score of 15 is obtained from 5-point Likert summed across the 3 questions for knowledge.)

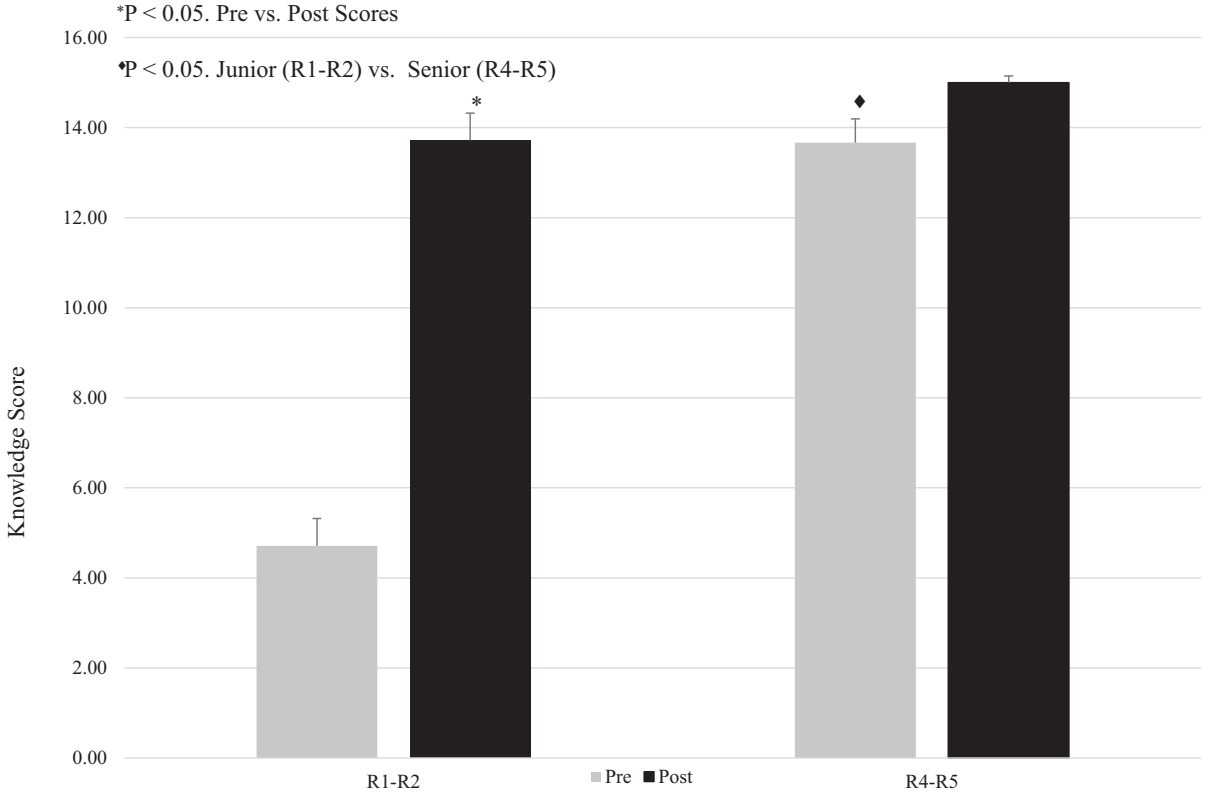

FIGURE 3. Linear stapler knowledge scores pre- and post-timeout (mean ± SEM).
(Maximum knowledge score of 15 is obtained from 5-point Likert summed across the 3 questions for knowledge.)

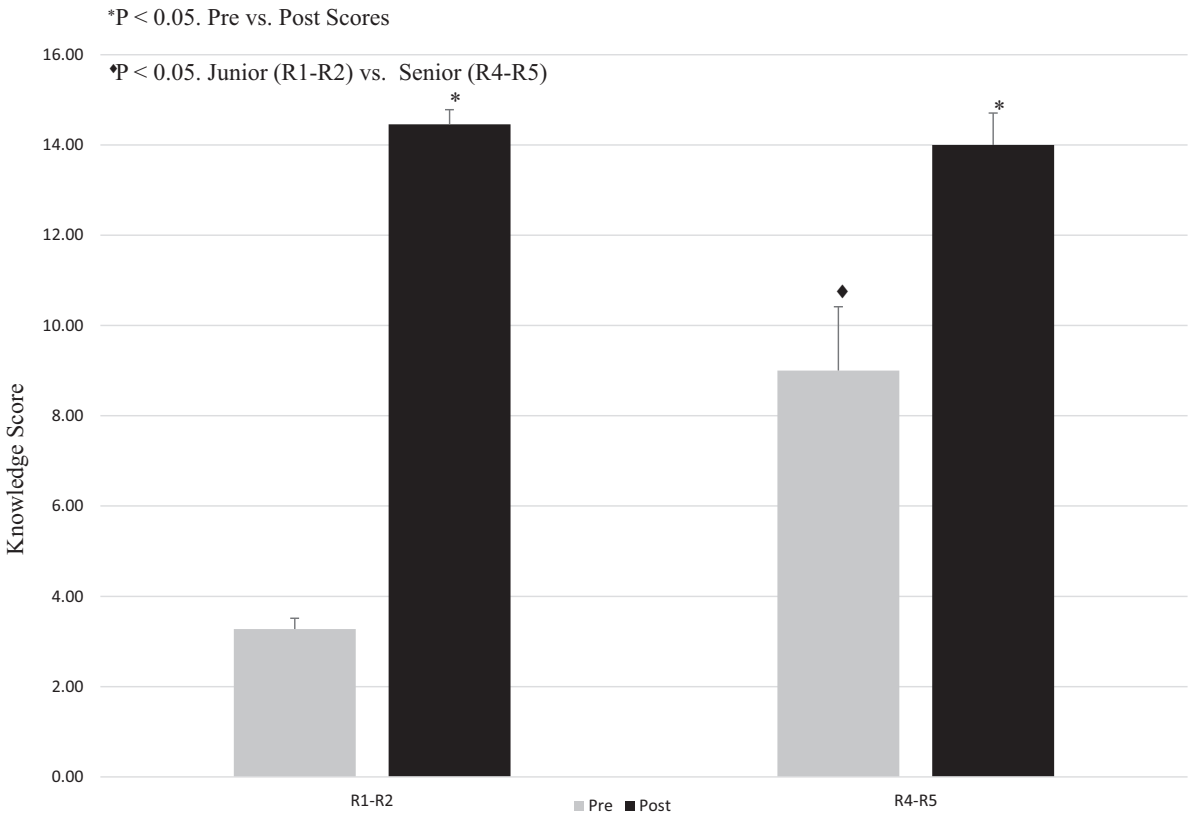

FIGURE 4. Circular stapler knowledge scores pre- and post-timeout (mean ± SEM).
(Maximum knowledge score of 15 is obtained from 5-point Likert summed across the 3 questions for knowledge.)

TABLE 2. Duration of Timeout in Minutes According to Resident Level and Type of Stapler Used (Shown as Mean ± SEM)

	R1-R2	R4-R5
Linear stapler	3.0 ± 0.1	1.7 ± 0.1*
Circular stapler	4.0 ± 0.1†	2.6 ± 0.2*,†

*p < 0.05. Junior (R1-R2) vs senior (R4-R5).
†p < 0.05. Linear stapler vs circular stapler.

It is possible that responses to the surveys may include professional desirability and conformity bias, as residents may have been inclined to provide professionally acceptable responses. Furthermore, cognitive bias is possible as the participants in our self-assessment study could have had the tendency to grade themselves better after an intervention if they perceived improvement as an expectation. However, residents expressed significant enthusiasm in their written comments that would support their survey responses.

Even with these limitations, we believe our findings provide meaningful insights into a novel educational approach for teaching surgical residents proper surgical stapler use.

An objective structured assessment of resident stapler proficiency would be an important next step in validating the findings of our self-assessment study.

CONCLUSIONS

Surgical educators are using varying formats to make their trainees proficient in surgical stapler use. As this study has demonstrated, an intraoperative instructional timeout just prior to stapler use by surgery residents has educational value and could be easily incorporated into the surgical training curriculum. Further research is warranted to determine whether this educational benefit can translate into reduced stapler user errors.

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SUPPLEMENTARY INFORMATION

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.jsurg.2019.05.005.