Intraoperative Feedback: A Video-Based Analysis of Faculty and Resident Perceptions

Priya H. Dedhia, MD, PhD,[a] Meredith Barrett, MD,[a] Graham Ives, MD,[a] Christopher P. Magas, MBS,[a] Oliver A. Varban, MD,[a] Sandra L. Wong, MD,[b] and Gurjit Sandhu, PhD[a]

[a]Department of Surgery, Michigan Medicine, Ann Arbor, Michigan; and [b]Department of Surgery, Dartmouth-Hitchcock, Lebanon, New Hampshire

OBJECTIVE: Residents and faculty identify intraoperative feedback as a critical component of surgical education. Studies have demonstrated that residents perceive lower quality and frequency of intraoperative feedback compared to faculty. These differences in perception may be due to dissimilar identification of feedback. The purpose of this study was to determine if residents and faculty differently identify intraoperative interactions as feedback.

DESIGN: Residents and faculty viewed a segment of a laparoscopic cholecystectomy video and then time-stamped the video where they perceived moments of intraoperative feedback. Validated surveys on timing, amount, specificity, and satisfaction with operative feedback were administered.

SETTING: Viewing of the video and survey administration was conducted at the University of Michigan.

PARTICIPANTS: A total of 23 of 41 residents (56%) and 29 of 33 faculty (88%) participated in this study.

RESULTS: Survey analysis demonstrated that residents perceived operative feedback to occur with less immediacy, specificity, and frequency compared to faculty. During the 10-minute video, residents and faculty identified feedback 21 and 29 times, respectively ($p = 0.13$). Ten-second interval analysis demonstrated 7 statistically significant intervals ($p < 0.05$) where residents identified feedback less frequently than faculty. Analysis of these 7 intervals revealed that faculty were more likely to identify interactions, especially nonverbal ones, as feedback. Review of free-text comments confirmed these findings and suggested that residents may be more receptive to feedback at the conclusion of the case.

CONCLUSIONS: Using video review, we show that residents and faculty identify different intraoperative interactions as feedback. This disparity in identification of feedback may limit resident satisfaction and effective intraoperative learning. Timing and labeling of feedback, continued use of video review, and structured teaching models may overcome these differences and improve surgical education. (J Surg Ed 76:906–915. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Intraoperative, Feedback, Video, Laparoscopic cholecystectomy, Technical skills, Resident learners

COMPETENCIES: Patient Care, Interpersonal and Communication Skills

ABBREVIATIONS: BID, Briefing, Intraoperative teaching, and Debriefing; PGY, Postgraduate year

INTRODUCTION

Recently, surgical resident education has encountered constant pressure to adapt to decreased autonomy, increased medico-legal responsibilities, and the need to master a rising number of surgical techniques and nonoperative skills.[1–3] Because of these constraints, increased emphasis has been placed on making operative experiences as meaningful as possible.[4–6] The current paradigm of operative education is based on "discovery learning," which focuses on accumulation of experience and self-directed learning.[7] However, implementation of faculty supported "guided discovery learning" results in more efficient and accurate learning than use of pure

Funding/Support: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Correspondence: Inquiries to Gurjit Sandhu, PhD, Department of Surgery, Section of General Surgery, 2207 Taubman Center, 1500 E. Medical Center Drive, SPC 5346, Ann Arbor, MI 48109; fax: 734-763-5615; e-mail: gurjit@med.umich.edu

  1931-7204/$30.00 https://doi.org/10.1016/j.jsurg.2019.02.003

(unguided) discovery learning.[8] As such, a central feature of guided learning includes incorporation of interactive feedback into daily practice patterns.[7,9–11]

Effective feedback uses the knowledge and proficiency level of the learner to provide a clear understanding of the goal and how to make progress towards that goal.[10,11] Moreover, immediate informative feedback is essential for optimal improvement of performance.[12,13] Inadequate feedback results in minimal improvement even for highly motivated learners.[12,14] Providing adequate feedback requires recognition that feedback has occurred[15] as well as faculty competence in delivering feedback and resident ability to receive and respond to feedback.[14] Ineffective feedback results from learner misinterpretation of feedback as well as unintended or lack of response to feedback.[11] As such, understanding resident and faculty perceptions is critical to effective delivery and receipt of feedback.

Survey-based studies have identified differences in resident and faculty perceptions of timing, amount, specificity, and effectiveness of feedback.[16–19] However, survey-based studies lack the ability to describe the type of feedback accurately and also fail to identify nonverbal forms of feedback. Video review has the potential to minimize recall bias and eliminate variation by allowing all viewers to review identical video footage. Furthermore, video review can supplement survey-based studies by adding new levels of granularity after studying interactions that are deemed important by participants.

To date, video review has frequently been used to supplement self-directed learning, coaching, evaluate technical performance or understanding of operative procedures, and assess patient interactions.[20–31] To our knowledge, we designed the first study to use video review to study differences in perceptions of feedback. We designed this study to confirm the findings of previous survey-based studies on perceptions of perioperative feedback between faculty and residents. We also sought to supplement survey data by (1) determining if residents and faculty would differently identify moments of operative feedback during video review of a laparoscopic cholecystectomy and (2) characterizing any differently perceived moments.

MATERIAL AND METHODS

Study Design

A schematic of the study design is shown in Figure 1. This study was deemed exempt by the Institutional Review Board at the University of Michigan (IRB no. HUM00084551). This study involved video review of a laparoscopic cholecystectomy performed by a postgraduate year (PGY) 2 surgical resident and a faculty surgeon. Video of a junior resident and a tenured faculty surgeon were chosen to maximize possible feedback events. Laparoscopic cholecystectomy was selected for several reasons. With over 700,000 cases performed annually, laparoscopic cholecystectomy is one of the most common cases performed in the United States.[32] Furthermore, its minimally invasive nature permits external and intraabdominal viewing.[33] Also, laparoscopic cholecystectomy has frequently been studied as a model procedure for skills assessment and education.[34–37] Videos of laparoscopic surgery were recorded using a video capture device connected to the laparoscope (Storz AIDA, DVD SCB 202040-20 Endoscopy Image and Video Capture). The external footage was captured using an Apple iPad Mini 2 (Apple, Cupertino, California). External and laparoscopic videos were synchronized and combined using iMovie 10 (Apple, Cupertino, California). A continuous 10-minute video was extracted that captured 5 minutes before and 5 minutes after identification of the critical view of safety, which involves complete dissection of the cystic duct and cystic artery prior to division.[33,38] Identification of the critical view of safety is known to minimize bile duct injury during laparoscopic cholecystectomy. We chose 5 minutes prior to and after acquisition of the critical view to provide a rich opportunity for feedback.

Next, participants independently reviewed the 10-minute video excerpt in iMovie 10 and were instructed to identify each moment where a new piece of feedback was initiated by timestamping the video (Fig. 1). Immediately after watching the video, participants completed an online modified version of a previously developed survey tool.[19] This tool was piloted to a group of 3 residents and 4 faculty for readability and comprehension prior to administration (Supplemental Tables 1-2). The first part of the survey asked respondents to provide details about the types of feedback observed in the video. In the second section of the survey, participants were asked to convey their opinions on their current perioperative feedback experiences at our institution using a 5-point Likert scale and provide responses to open-ended questions.

Participants

Forty-one residents and thirty-three faculty from the general surgery residency program at the University of Michigan Hospital and Health Systems were recruited via email invitation to review videos. Participation was voluntary and consent was obtained. Residents and faculty participated over the course of 1.5 nonoverlapping months.

Data Collected

Data were collected electronically from October to December 2015. Survey data were linked to video data

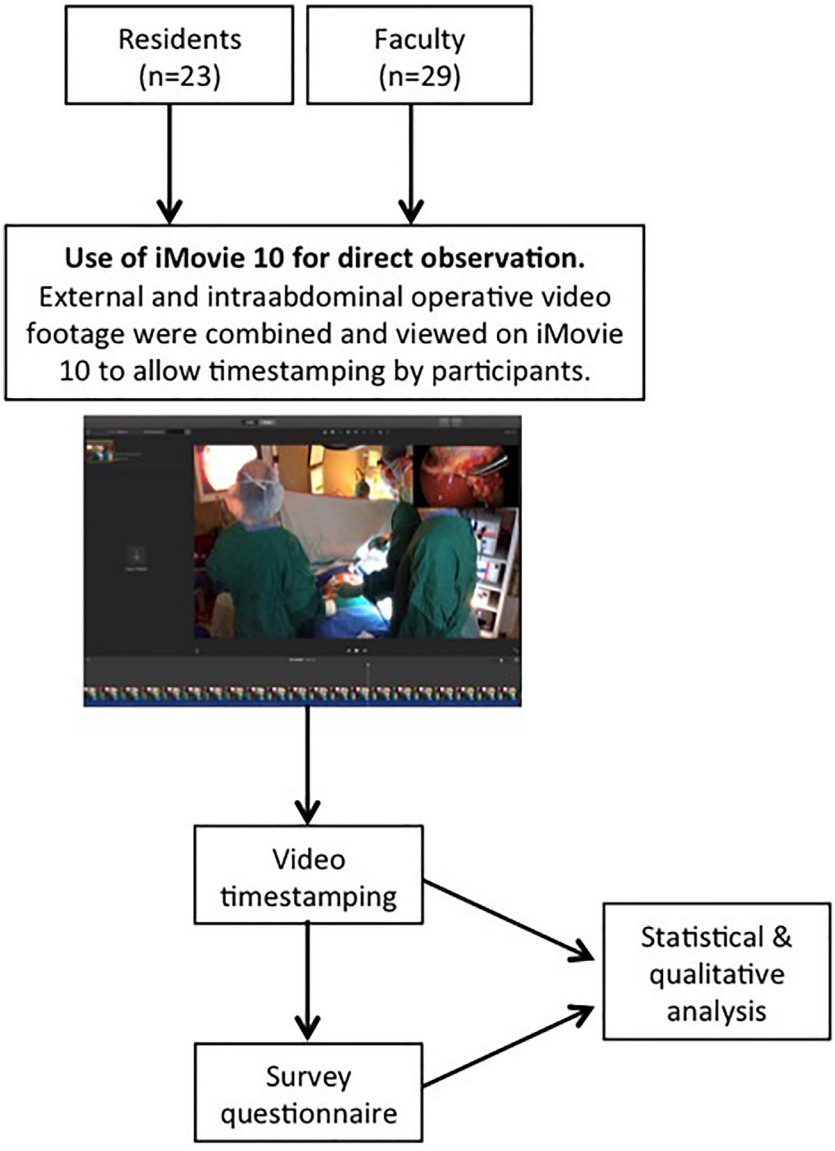

FIGURE 1. Overview of study design. Residents and faculty viewed a video excerpt of external and intra-abdominal laparoscopic cholecystectomy footage and indicated each new moment of feedback by video timestamping. Surveys were also completed by participants. Video timestamping and survey results were subjected to quantitative and qualitative analysis.

using a unique identifier. Timestamps were exported from iMovie into Final Cut Pro X 10.2.2 (Apple, Cupertino, California) to view and analyze markers. Results were anonymized prior to coding and analysis. Resident and faculty timestamping of feedback during the entire 10-minute video were compared. The video was reviewed in 10-second intervals in order to identify the distribution of feedback events. The number of time-stamped events during each 10-second interval of the video was compared in order to further assess specific moments of discrepancy between residents and faculty. Ten-second intervals were also selected to identify granular yet meaningful interaction. Survey responses were collected and analyzed. Free text comments were also reviewed for content.

Statistical Analysis

Comparisons of video timestamping and survey responses were made using Student *t* tests. Statistical analyses were performed using SPSS (IBM, Armonk, New York) and Microsoft Excel (Microsoft, Redmond, Washington). A p value of less than 0.05 was considered

statistically significant. Subgroup analysis was not conducted because of the small sample size in each cohort.

RESULTS

Study Participants

The overall participation rate was 70% (52 of 74), which consisted of 56% of residents (23 of 41) and 88% of faculty members (29 of 33). The average PGY level of the residents was 3.96 ± 2.2 years (mean ± SD). Junior residents (PGY1-2) represented 30.4% of respondents. Resident and faculty demographics are shown in Table 1.

Survey Findings

Our survey results demonstrated that residents and faculty generally agreed on the importance of the timing and the subject areas of feedback. The only exception was feedback on knowledge of anatomy, which was identified as slightly less important by residents ($p = 0.01$; Fig. 2). Consistent with previous studies, residents indicated that operative feedback occurred with decreased immediacy, specificity, and frequency than faculty (Fig. 2).[16–19] This difference was most notable for specificity of feedback, $p < 0.0005$. Residents and faculty demonstrated no significant difference regarding overall satisfaction with operative feedback, $p = 0.12$. Interestingly, faculty believed that residents solicited feedback less frequently than residents themselves indicated, $p = 0.021$. For all subject areas of feedback queried, residents perceived feedback less frequently than faculty, but this was most prominent for knowledge of anatomy, $p < 0.0005$. 69.0% of faculty indicated that their ability to give feedback was rarely influenced by lack of instruction on delivery of feedback. A total of 55.2% of faculty indicated that concern for offending the resident rarely influenced their ability to give feedback. A total of 82.8% of faculty indicated that concern for resident evaluations rarely prevented their ability to give feedback. Finally, 55.2% of faculty indicated that time constraints impeded the ability to deliver feedback half or more of the time.

TABLE 1. Demographics of Residents and Faculty Who Participated in the Study

Residents	n (%)	Faculty	n (%)
Total	23	Total	29
Male	17 (73.9)	Male	19 (65.5)
Female	6 (26.1)	Female	10 (34.5)
PGY1	4 (17.4)	Assistant professor	12 (41.4)
PGY2	3 (13.0)	Associate professor	9 (31.0)
PGY3	3 (13.0)	Professor	8 (27.6)
ADT year 1	3 (13.0)		
ADT year 2	3 (13.0)		
PGY4	3 (13.0)		
PGY5	4 (17.4)		

ADT, academic development time is a dedicated year of research.

Quantitative Analysis of Video Review

Residents and faculty were asked to review a 10-minute segment of video footage of a laparoscopic cholecystectomy and identify each moment of feedback. After review of the video segment, residents on average identified fewer moments of feedback (21.1 ± 13.6) compared to faculty (29.3 ± 21.5); however, this was not statistically significant (mean ± SD; $p = 0.13$, Fig. 3A). When analyzing the video segment in 10-second intervals to identify granular yet meaningful interactions, faculty identified feedback more frequently than residents at 7 discrete intervals ($p < 0.05$, Fig. 3B).

Characterization of Differently Identified Intervals and Free Text Responses

The 7 differently perceived intervals identified on quantitative timestamp analysis were assessed for potential patterns, and 3 key patterns were noted (Table 2). First, all differently identified intervals lacked explicit mention of "feedback" by faculty or residents. Second, faculty were always more likely to identify an event as feedback compared to residents. Third, 3 of the 7 differently identified intervals included nonverbal interactions, such as pointing to the monitor. These data indicate that none of the 7 interactions were overtly labeled as feedback by the attending or resident being videotaped, thus necessitating subjective identification of an event as feedback by resident and faculty video reviewers. Furthermore, faculty are more likely to identify any interaction as feedback compared to residents including nonverbal interactions.

Free-text comments by residents and faculty supported these patterns (Table 3). In addition, free text comments suggested that residents may be more receptive to feedback at the conclusion of the case (Table 3). Together, these data suggest that differences in perception of intraoperative feedback between residents and faculty may in part be due to differences in identification of an intraoperative event as feedback.

DISCUSSION

In this study, we implemented surveys to demonstrate that resident and faculty perceptions of operative feedback are different. We then applied video review of a laparoscopic cholecystectomy to show that these differences in perceptions of feedback may be partly due to disparate identification of intraoperative interactions as feedback. Overall, our key findings indicate that residents are less likely to identify

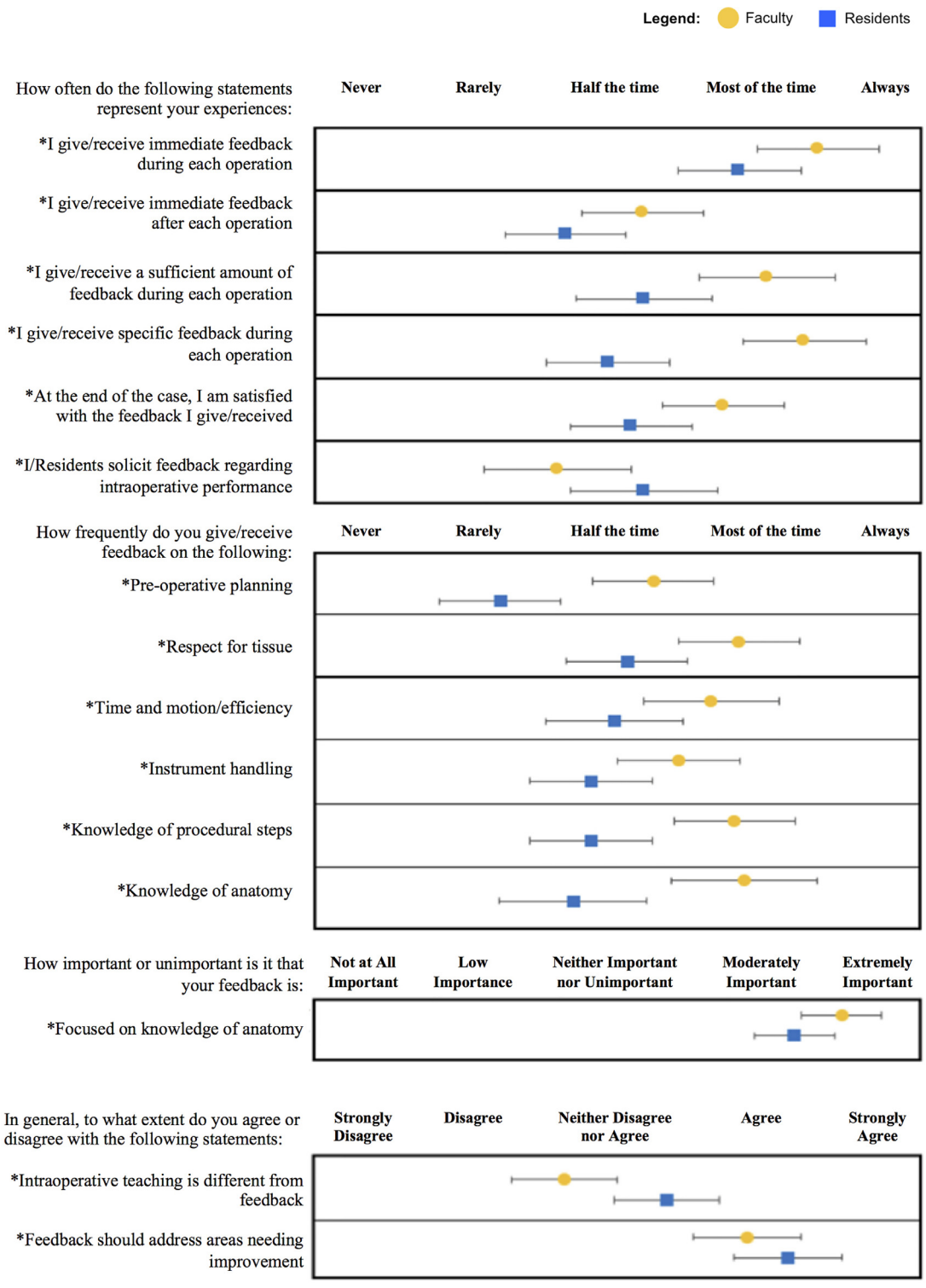

FIGURE 2. Significant Survey Results. Comparison of resident and faculty survey responses relating to feedback. A five point Likert scaling system was used for all questions asked, with possible responses listed at the top of each table. Mean results are displayed (yellow circles represent faculty responses; blue squares represent resident responses). Bars represent 95% confidence intervals. *$p < 0.05$ as determined by *t* test.

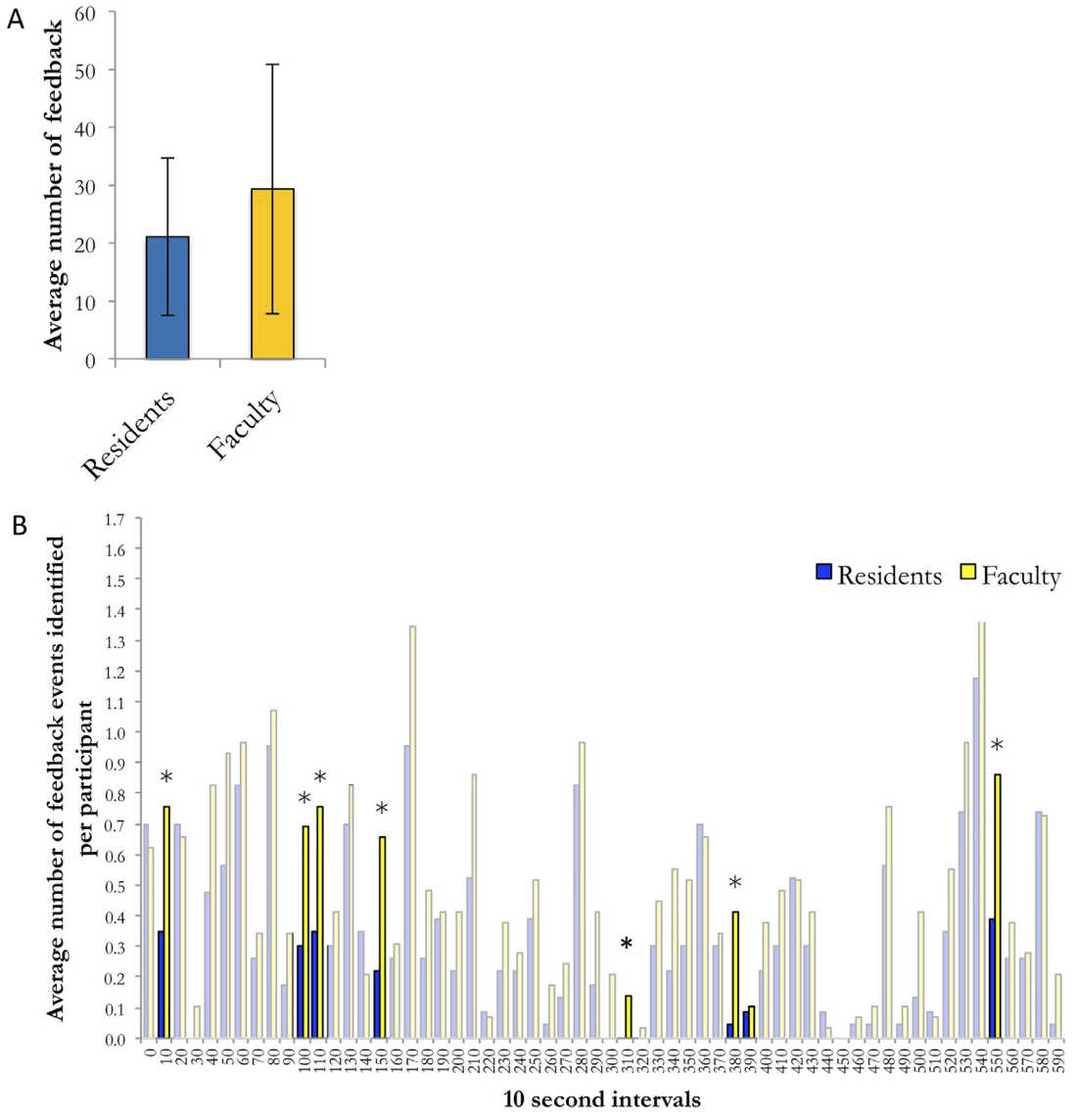

FIGURE 3. Resident and faculty identified feedback events on video review. (A) The average number of feedback events identified per participant during the 10-minute video segment is shown for residents and faculty. Error bars indicate standard deviation. Mann-Whitney *U* statistical analysis yielded p = 0.13. (B) Average number of feedback events per participant for each 10-second interval during the 10-minute video segment are indicated for residents and faculty. *p < 0.05 as determined by Student *t* test.

a particular constellation of intraoperative interactions as feedback compared to faculty. As such, our work is the first to demonstrate that video review can be used to study perceptions and can supplement survey findings.

In agreement with Jensen et al., our survey findings demonstrated that residents perceived operative feedback as being less frequent, specific, and timely compared to faculty.[19] Interestingly, however, resident participants in our study demonstrated no statistical difference in overall satisfaction with operative feedback compared to faculty. This may be due to the fact that residents may place increased weight on a small number of effective feedback interactions that contribute to overall skill development; however, further studies will be needed to characterize this finding.

In 12% (7 out of 60) of the 10-second intervals, residents were less likely to identify feedback resulting in potentially missed opportunities for learning and improvement in response to feedback. These observations indicate that one's position, either as resident or faculty, influences how feedback is observed and experienced. The varying responses between the 2 groups, despite review of the same operative excerpt, suggest diverging perceptions of feedback. The interactions that were preferentially identified as feedback by faculty were not overtly labeled as feedback in the video and

TABLE 2. Analysis of Events Differentially Identified As Feedback

10s time interval	Residents That Identified Feedback Events, n (%)	Faculty That Identified Feedback Events, n (%)	Transcript
10-20	8 (34.8)	22 (75.9)	Faculty: Ah see, you're getting there man. Spread there a little bit. Yeah, this is so great. Look at that. Just keep working and working and eventually it all comes out.
100-110	7 (30.4)	20 (69.0)	Faculty: Mhmm. Mhmm. Mhmm. Yeah.
110-120	8 (34.8)	22 (75.9)	Faculty: Yup. I like that. My intuition tells me there's a little spot there that will give.
150-160	5 (21.7)	19 (65.5)	Faculty: Do that one more time. You can see it's a little nothing and it's going right into the gallbladder. Just let that sit for a minute. Get this stuff over here down. Faculty points to monitor
300-310	0 (0)	6 (20.7)	Faculty: We'll take those little things crossing there. I don't know if they're little vessels or lymphatics. Faculty points to monitor
380-390	1 (4.3)	12 (41.4)	Faculty: We can put one clip here, one clip here and cut between those. Want to do that? Resident: I agree. Faculty: Clip please. Clip applier please. Okay. Faculty points to monitor
550-560	9 (39.1)	25 (86.2)	Faculty: Mhmm. The whole thing is just being so beautiful man! Where do you think the artery is?

TABLE 3. Characterization of Free Text Comments

	Faculty are More Likely Than Residents to Identify an Event As Feedback
Resident	1. As I've gotten more senior, I've noticed that only certain attendings make it a point to give directed and specific feedback. The overwhelming majority will give zero feedback. It seems there's more comfort with giving feedback to junior residents because it's more elementary and general skills. Perhaps there should be some education regarding how to actually gauge the performance of senior residents in order to provide high quality feedback. 2. Generally, intraoperative teaching is done a lot while specific, resident-focused feedback is less common. I most appreciate attendings who point out specific actions that I am either doing well or things that I am doing incorrectly. I least appreciate those who take the instrument away without explaining exactly what I am doing wrong.
Faculty	1. Typically, I will deliver feedback as the case progresses after asking them to perform each task. This is verbal to begin with and if still unclear, I will show them how to perform the task. This seems to be quite effective. 2. Ideally feedback is given continuously throughout the procedure. In emergent situations, feedback that disrupts performance may have to be deferred until after the case is finished.
	Nonverbal Interactions May Be Identified As Feedback by Faculty
Resident	Residents did not provide relevant comments.
Faculty	1. There was verbal feedback, which was almost non-stop. It was positive, corrective, general and sometimes very specific. In addition there was a lot of hands on feedback, which involved correcting the angle of the camera, direction of retraction, angle of instrument etc. 2. Feedback was continuous for all steps of the procedure, very specific with regard to what the resident should do at the specific time. Also feedback with regard to how to divide specific structures. Some feedback was not verbal, i.e. attending moved the resident hand to provide more retraction on the infundibulum for better visualization for dissection of the critical view of safety.
	Residents May Be More Receptive to Feedback at Conclusion of Case
Resident	1. I wish we received more feedback postoperatively when I have time to really digest what I'm being told. This feedback can even be just one area to focus on so that next time I do a case with that attending, I'll be sure to keep that in mind. 2. I wish I could get more feedback on improving efficiency. I appreciate the intra-op feedback but would like more "big-picture" strengths/weakness feedback after cases so I know where to focus and how to improve for the following cases.
Faculty	1. I provide ongoing feedback throughout the operation. I try to debrief after an operation but most often forget.

included nonverbal interactions. These findings suggest that residents are less likely to interpret an intraoperative interaction as feedback. Comments from residents also indicate that intraoperative interactions are more likely to be interpreted by residents as intraoperative teaching rather than feedback (Table 3). Feedback in clinical education has been defined as information on a trainee's observed performance in comparison with a standard in order to improve the trainee's performance.[39] Importantly, feedback is learner-centered in that it is personalized and oriented to the trainee's goals.[14,40,41] Teaching, on the other hand, is educator-centered, and content is structured as a one-way transfer of knowledge and skills.[42] In this study we intentionally withheld definitions of teaching or feedback. Residents may have been more likely to identify intraoperative interactions as teaching rather than feedback because intraoperative interactions may not be aligned to the goals of the trainee. For example, one resident commented, "I get relatively little feedback, and it usually focuses on minute or less-important aspects of the procedure." Additional studies are necessary to delineate why residents are less likely to identify certain interactions as feedback. However, identifying trainee goals and labeling interactions as feedback may facilitate reception of feedback by the trainee.

Interestingly, faculty comments suggested that nonverbal feedback was an integral component to intraoperative feedback. In contrast, however, no residents commented on nonverbal feedback signifying that residents may not recognize nonverbal feedback. Our results differed from previous survey-based findings, which demonstrated no difference between faculty and resident perceptions of nonverbal feedback.[16] This difference is in part due to recall bias, which is inherent to survey-based findings. Finally, multiple resident comments specify that residents may not be primed to receive feedback during the procedure, but may be more receptive to feedback immediately postoperatively. An interaction that occurs immediately postoperatively may facilitate bidirectional and thus personalized conversation, thereby allowing the trainee to identify the interaction as feedback.

Together, these data suggest that changes in delivery and reception of feedback may enhance intraoperative learning. Our data suggest that labeling of feedback during the delivery of verbal and nonverbal feedback as well as review of feedback immediately postoperatively may surmount challenges to intraoperative surgical education by optimizing reception of feedback and intraoperative learning.

One educational framework that intentionally integrates feedback into surgical practice is the **B**riefing, **I**ntraoperative teaching, and **D**ebriefing (BID) model.[4] This model implements a preoperative briefing in which specific learner objectives are established; intraoperative feedback, which focuses on those objectives; and a debriefing at the end of the case, which provides recommendations for future improvement.[4] The BID model accounts for the importance of specificity, learner involvement, and goal orientation in operative feedback.[4] Application of the BID model has resulted in improved resident perception of nonverbal feedback in addition to the frequency, clarity, and effectiveness of operative feedback. These findings suggest that the BID model may prime both the teacher and learner to administer and receive feedback.[12] Our results, which show varying perceptions of specificity, learner involvement, goal orientation, and nonverbal feedback by residents and faculty, support use of the BID model, which may improve the intraoperative learning environment for the resident learner. However, free text comments from faculty in our survey revealed that the immediately postoperative debrief was felt to be unnecessary because preoperative briefing and intraoperative feedback were sufficient. Further studies are necessary to determine if the postoperative debrief results in improved alignment of expectations of feedback by both residents and faculty. Certainly, it will be interesting to apply video review after implementation of the BID model to determine how residents and faculty may differentially perceive the postoperative debrief.

This study has several limitations. Participation from a single institution may limit generalizability. The resident and faculty portrayed in the video were members of the General Surgery program at the University of Michigan and were likely to be familiar to respondents. Thus, prior interactions with either individual may have altered timestamping of feedback by study participants. In addition, the study was performed over the course of 3 months. Respondents that participated near the study conclusion, may have been influenced by the opinions of early participants. Furthermore, we analyzed the video segment in 10-second increments in order to permit detailed examination of single interactions. Further studies with a greater number of participants will be required to perform alternative interval division analysis. Moreover, due to our limited sample size we were also unable to perform subgroup analysis. Finally, as with all studies with voluntary participation, results may reflect selection bias. Faculty participation of 88% suggests this bias is less likely to play a role in faculty results than resident results where participation is 56%.

CONCLUSIONS

In conclusion we confirmed that surgical residents and faculty members have differing perceptions on operative

feedback. Here, we used a novel video review methodology to characterize perceptions of feedback during the course of an operation. This method is widely applicable to other learning environments such as medical education or patient education where elucidation of differences of perception is necessary.

ACKNOWLEDGMENTS

The authors would like to thank Ali Jones for her assistance with construction of the website on which the survey was administered. We also thank Lauren Wancata, M. D. and Niki Matusko, B.S. for critical review of the manuscript. Niki Matusko also provided statistical support.

Ethical approval: This study was deemed exempt by the Institutional Review Board at University of Michigan on April 8, 2015 (HUM00084551).

REFERENCES

1. Teman NR, Gauger PG, Mullan PB, Tarpley JL, Minter RM. Entrustment of general surgery residents in the operating room: factors contributing to provision of resident autonomy. *J Am Coll Surg*. 2014;219:778–787.
2. Malangoni MA, Biester TW, Jones AT, Klingensmith ME, Lewis FR. Jr. Operative experience of surgery residents: trends and challenges. *J Surg Educ*. 2013;70:783–788.
3. Champagne BJ. Effective teaching and feedback strategies in the OR and beyond. *Clin Colon Rectal Surg*. 2013;26:244–249.
4. Bell Jr. RH. Why Johnny cannot operate. *Surgery*. 2009;146:533–542.
5. Chung RS. How much time do surgical residents need to learn operative surgery? *Am J Surg*. 2005;190:351–353.
6. Snyder RA, Tarpley MJ, Tarpley JL, et al. Teaching in the operating room: results of a national survey. *J Surg Educ*. 2012;69:643–649.
7. Roberts NK, Williams RG, Kim MJ, et al. The briefing, intraoperative teaching, debriefing model for teaching in the operating room. *J Am Coll Surg*. 2009;208:299–303.
8. Mayer RE. Should there be a three-strikes rule against pure discovery learning? *Am Psychol*. 2004;59:14–19.
9. Accreditation Council for Graduate Medical Education. Program requirements for graduate medical education in surgery. Available at: http://www.acgme.org/acgmeweb/portals/0/pfassets/programrequirements/440_general_surgery_07012014.pdf. Accessed December 28, 2015.
10. Ende J. Feedback in clinical medical education. *JAMA*. 1983;250:777–781.
11. Black P, William D. Developing the theory of formative assessment. *Educ Asses Eval Acc*. 2009;21:5–31.
12. Ericsson KA, Krampe RT, Tesch-Romer C. The role of deliberate practice in the acquisition of expert performance. *Psychol Rev*. 1993;100:363–406.
13. Hupp JR. Strengthening feedback in surgical education. *J Oral Maxillofac Surg*. 2017;75:229–231.
14. Hewson MG, Little ML. Giving feedback: verification of recommended techniques. *J Gen Intern Med*. 1998;13:111–116.
15. Hoffman RL, Petrosky JA, Eskander MF, et al. Feedback fundamentals in surgical education: tips for success. *Bull Am Coll Surg*. 2015;100:35–39.
16. Butvidas LD, Anderson CI, Balogh D, et al. Disparities between resident and attending surgeon perceptions of intraoperative teaching. *Am J Surg*. 2011;201:385–389.
17. Liberman AS, Liberman M, Steinert Y, et al. Surgery residents and attending surgeons have different perceptions of feedback. *Med Teach*. 2005;27:470–472.
18. Rose JS, Waibel BH, Schenarts PJ. Disparity between resident and faculty surgeons' perceptions of preoperative preparation, intraoperative teaching, and postoperative feedback. *J Surg Educ*. 2011;68:459–464.
19. Jensen AR, Wright AS, Kim S, et al. Educational feedback in the operating room: a gap between resident and faculty perceptions. *Am J Surg*. 2012;204:248–255.
20. Vaughn CJ, Kim E, O'Sullivan P, et al. Peer video review and feedback improve performance in basic surgical skills. *Am J Surg*. 2016;211:355–360.
21. Scott DJ, Rege RV, Bergen PC, et al. Measuring operative performance after laparoscopic skills training: edited videotape versus direct observation. *J Laparoendosc Adv Surg Tech A*. 2000;10:183–190.
22. Beard JD, Jolly BC, Newble DI, Thomas WE, Donnelly J, Southgate LJ. Assessing the technical skills of surgical trainees. *Br J Surg*. 2005;92:778–782.

23. Zevin B, Bonrath EM, Aggarwal R, et al. Development, feasibility, validity, and reliability of a scale for objective assessment of operative performance in laparoscopic gastric bypass surgery. *J Am Coll Surg*. 2013;216:955–965. e8.

24. Abdelsattar JM, Pandian TK, Finnesgard EJ, et al. Do You see what I see? How we use video as an adjunct to general surgery resident education. *J Surg Educ*. 2015;72:e145–e150.

25. Trelease RB. From chalkboard, slides, and paper to e-learning: How computing technologies have transformed anatomical sciences education. *Anat Sci Educ*. 2016. Epub.

26. Makary MA. The power of video recording: taking quality to the next level. *JAMA*. 2013;309:1591–1592.

27. Birkmeyer JD. Surgical skill and complication rates after bariatric surgery. *N Engl J Med*. 2013;369:1434–1442.

28. Herrera-Almario GE. The effect of video review of resident laparoscopic surgical skills measured by self- and external assessment. *Am J of Surg*. 2016;211:315–320.

29. Paskins Z1, McHugh G, Hassell AB. Getting under the skin of the primary care consultation using video stimulated recall: a systematic review. *BMC Med Res Methodol*. 2014;14:101.

30. Hu YY, Peyre SE, Arriaga AF, et al. Postgame analysis: using video-based coaching for continuous professional development. *J Am Coll Surg*. 2012;214:115–124.

31. Alken A, Tan E, Luursema JM, Fluit C, van Goor H. Coaching during a trauma surgery team training: perceptions versus structured observations. *Am J Surg*. 2015;209:163–169.

32. Stokes CS, Krawczyk M, Lammert F. Gallstones: environment, lifestyle and genes. *Dig Dis*. 2011;29:191–201.

33. Strasberg SM, Hertl M, Soper NJ. An analysis of the problem of biliary injury during laparoscopic cholecystectomy. *J Am Coll Surg*. 1995;180:101–125.

34. Smith SG, Torkington J, Brown TJ, Taffinder NJ, Darzi A. Motion analysis. *Surg Endosc*. 2002;16:640–645.

35. Vassiliou MC, Feldman LS, Andrew CG, et al. A global assessment tool for evaluation of intraoperative laparoscopic skills. *Am J Surg*. 2005;190:107–113.

36. Chang L, Hogle NJ, Moore BB, et al. Reliable assessment of laparoscopic performance in the operating room using videotape analysis. *Surg Innov*. 2007 Jun;14:122–126.

37. Kramp KH, van Det MJ, Hoff C, Lamme B, Veeger NJ, Pierie JP. Validity and reliability of global operative assessment of laparoscopic skills (GOALS) in novice trainees performing a laparoscopic cholecystectomy. *J Surg Educ*. 2015;72:351–358.

38. Strasberg SM, Brunt LM. Rationale and use of the critical view of safety in laparoscopic cholecystectomy. *J Am Coll Surg*. 2010;211:132–138.

39. van de Ridder JM1, Stokking KM, McGaghie WC, et al. What is feedback in clinical education? *Med Educ*. 2008;42:189–197.

40. Bienstock JL, Katz NT, Cox SM, et al. To the point: medical education reviews—providing feedback. *Am J Obstet Gynecol*. 2007;196:508–513.

41. Kornegay JG, Kraut A, Manthey D, et al. Feedback in medical education: a critical appraisal. *AEM Educ Train*. 2017;1:98–109.

42. Dreyfus SE. The five-stage model of adult skill acquisition. *Bull Sci Technol Soc*. 2004;24:177–181.

SUPPLEMENTARY INFORMATION

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jsurg.2019.02.003.