

Postgame Analysis: Using Video-Based Coaching for Continuous Professional Development

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- BACKGROUND:** The surgical learning curve persists for years after training, yet existing continuing medical education activities targeting this are limited. We describe a pilot study of a scalable video-based intervention, providing individualized feedback on intraoperative performance.
- STUDY DESIGN:** Four complex operations performed by surgeons of varying experience—a chief resident accompanied by the operating senior surgeon, a surgeon with less than 10 years in practice, another with 20 to 30 years in practice, and a surgeon with more than 30 years of experience—were video recorded. Video playback formed the basis of 1-hour coaching sessions with a peer-judged surgical expert. These sessions were audio recorded, transcribed, and thematically coded.
- RESULTS:** The sessions focused on operative technique—both technical aspects and decision-making. With increasing seniority, more discussion was devoted to the optimization of teaching and facilitation of the resident's technical performance. Coaching sessions with senior surgeons were peer-to-peer interactions, with each discussing his preferred approach. The coach alternated between directing the session (asking probing questions) and responding to specific questions brought by the surgeons, depending on learning style. At all experience levels, video review proved valuable in identifying episodes of failure to progress and troubleshooting alternative approaches. All agreed this tool is a powerful one. Inclusion of trainees seems most appropriate when coaching senior surgeons; it may restrict the dialogue of more junior attendings.
- CONCLUSIONS:** Video-based coaching is an educational modality that targets intraoperative judgment, technique, and teaching. Surgeons of all levels found it highly instructive. This may provide a practical, much needed approach for continuous professional development. (*J Am Coll Surg* 2012;214:115–124. © 2012 by the American College of Surgeons)
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Although central to a surgeon's profession, operative skill remains a poorly defined construct. Despite the fact that the majority of adverse surgical events are attributable to technical error,^{1,2} and despite repeated calls by the American College of Surgeons³ and the American Surgical Association⁴ for technical evaluation and retooling, no evidence-based method exists to help surgeons evaluate, much less improve, their intraoperative performance. Traditionally, operative privileges have been granted based on proxies for skill such as completion of residency, board certification, personal recommendations, and case volumes rather than on any concrete measure of technical competence. The inadequacy of these metrics in capturing technical skill has been described both within and outside the discipline of surgery.³⁻⁷

Research has demonstrated an inverse relationship between surgeon volume and surgical mortality,⁸ as well as operative experience and surgical complication rates,⁹⁻¹¹

however, no one has definitively ascertained the minimum number of cases or years of experience needed to safely perform any particular operation. The highly individualized nature of the learning curve^{12,13} renders the possibility of finding a universally applicable threshold—whether expressed in caseload or time commitment—remote at best. In their study of the effect of practice experience on operative times and complication rates in reduction mammoplasty, Carty and colleagues¹¹ demonstrated considerable variance in performance, particularly among junior surgeons. Their data suggest that the surgical learning curve for even this “bread-and-butter” case persists for more than a decade beyond formal training. The length of time required to achieve expertise is an issue of increasing relevance in our current training environment, an era in which residents’ operative time is reduced¹⁴ secondary to work hour regulations, and is compounded by constant procedural and technologic innovation.^{5,7}

Thus, the need for a means of targeting individual technical skill and decision-making is critical. Although the adult learning literature condemns traditional continuing medical education,¹⁵ most educational interventions for surgeons incorporate its ineffective principles: teacher-rather than learner-driven, didactic rather than interactive, and amassed rather than distributed. The new paradigm, continuous professional development, aims to correct these inadequacies¹⁶ but is largely undeveloped in the operative domain. In fact, all existing methods of operative evaluation represent summative assessments; they attempt to depict the surgeon as a final product rather than an evolving practitioner. Formative assessments, consisting of qualitative, descriptive feedback targeted to the individual surgeon throughout the learning process, are better suited to the goal of practice modification and, therefore, continuous professional development. To our knowledge, none are in routine use in surgery.

Physician self-assessments are known to be unreliable.¹⁷ The use of a third party to provide perspective and immediate, targeted feedback is an intuitive approach that is well described in accelerated skill acquisition in other disciplines.¹⁸ Athletes are a particularly apt analogy; even the elite among them retain coaches. The world of sports provides a unique methodology as well: performances are routinely recorded and reviewed post-hoc with coaches who guide the learner throughout a longitudinal, self-directed improvement process. We sought to develop a methodology for continuous professional development in operative skill using video-based coaching. We report the results of a qualitative study designed to assess feasibility, gather feedback, and identify recurring themes of discussion that may be further refined into a scalable intervention.

Table 1. Operations under Review

Operation
Pancreaticoduodenectomy
Radical resection of large retroperitoneal sarcoma including adjacent organs; involvement of major blood vessels
Reoperation for resection of retroperitoneal mass including adjacent organs
Subtotal gastrectomy with celiac node dissection

METHODS

Over the past 2 years, we piloted and refined the use of audiovisual recording technology in the operating rooms at our institution. Our configuration allows us to record a view of the operative field in detail, a view of the entire operating room (OR), and all conversations in synchrony. This study was approved by the Partners Human Research Committee.

We reviewed the preadmission testing center and OR schedules to identify general surgery and surgical oncology operations with expected complication rates of greater than 20%. We invited a highly respected, recently retired surgical oncologist with extensive experience in all cases undergoing review to act as our surgical coach. He is widely recognized within our institution as an expert in operative management and is the surgeon to whom others most frequently turn for informal consultation both in and outside of the OR.

Five operative surgeons were offered an opportunity to engage in a single video review with our coach, with whom each is familiar; 4 invitations were accepted. These cases represented a wide spectrum of surgical experience (Table 1): a chief resident accompanied by the operating senior surgeon, a surgeon with less than 10 years in practice (junior surgeon), another with 20 to 30 years (senior surgeon), and a surgeon with more than 30 years of experience (very senior surgeon).

Residents were present in all operations. Because we intended coaching to be a mechanism for continuous professional development, based on actual practice, and because one of the roles of an academic surgeon is that of teacher, we decided against artificially assessing nonteaching cases; we believed that any points made about intraoperative performance in the absence of a resident would be limited in applicability. Surgeons were readily able to identify their residents’ and their own hands onscreen; resident involvement in the OR did not complicate the coaching sessions. Due to the potentially sensitive nature of coaching, residents were not included in coaching sessions until the very end of the study, after a number of our participants suggested it. For this final coaching session, we chose a case with a chief resident, as, by virtue of his seniority, he most closely approximated an independently practicing surgeon.

Table 2. Frequency of Use of Different Coaching Techniques

Technique used	Resident/senior surgeon	Junior surgeon	Senior surgeon	Very senior surgeon	Total
Surgeon-driven					23
Asking pointed questions	—	5	—	—	5
Narrating video	7	2	1	8	18
Coach-driven					63
Asking questions to prompt reflection	8	4	1	8	21
Suggesting alternative approaches	9 (6/3)	13	4	5	31
Framing in terms of resident performance	2	2	5	2	11

Numbers represent instances, eg, 5 instances of “asking pointed questions” were noted in the junior surgeon’s coaching session.

Both chief resident and operative attending were present, and coaching was directed at both as a team.

Video review sessions were scheduled in 1-hour blocks and were moderated by the principal investigator (CCG) and an educational psychologist (SEP). The moderators introduced each session by stating the overarching goal of the project: to review operative performance using the coach as a sounding board. It was explicitly stated that the goals of these sessions were to improve performance (formative evaluation) and not to develop an approach to formal evaluation for privileging or certification (summative assessment). Each participant was told to “talk through what happened” in his case, prioritizing topics of conversation as he saw fit. They were instructed to request fast forwarding as needed. The moderators also indicated that they would inquire about fast forwarding if the conversation seemed to stall. Surgeons were shown a video of the operative field as recorded by the in-light camera. As feedback accumulated throughout the roll-out of the project, we made preoperative imaging and the view from the room camera available during the review sessions; audio was not used for the purposes of this study. The review sessions were audio recorded, transcribed, and coded, using grounded theory analysis, for recurrent themes pertaining to coaching techniques, the content of the conversations, the educational value of the session, and ideas for improvement.

The study was closed when thematic saturation was reached; when discussion topics of the sessions started to recapitulate one another and new ones ceased to emerge, we stopped offering video review with our coach. Surgeons were still afforded the ability to review videos on their own; none, however, took advantage of this opportunity. The final number of cases, 4, represents 21 hours of operative time and is an expected and reasonable sample size for qualitative research.

RESULTS

Coaching techniques

The surgeon-coach discussions proceeded naturally, requiring little prompting on the part of the moderators. In every ses-

sion, the conversation was driven alternately by the surgeon and the coach; although all of our surgeons were active learners, able to direct the progression of their own coaching sessions, the coach also readily identified technical and/or decision-making points that were novel to each surgeon. The frequency with which each coaching technique appeared is shown in Table 2. Nearly 3 times as many instances were initiated by the coach as the operative surgeon.

Surgeon-driven

Surgeon-driven learning occurred in 2 ways. The first was best exemplified in the session of the junior surgeon, who arrived with specific questions in mind. This surgeon had the option of choosing either of 2 recorded cases, and he selected the more technically challenging one to review. Explaining that there had been a potentially “preventable intraoperative event,” his goal for the session was to “go over anything we could have done differently.” Throughout his coaching session, he explicitly queried the coach for advice about a range of topics, from positioning of the patient and assistants to dissection techniques.

All surgeons used an explanatory technique to engage the coach at some point during their session; they fast-forwarded to points of interest and narrated the events being replayed. The chief resident, the chief resident’s attending surgeon, and the very senior surgeon each used this technique in 7 to 8 instances. However, its intent seemed to differ with seniority. The attending surgeons generally provided a rationale for their onscreen actions and/or for choosing a particular moment to review:

Surgeon: What I do is dissect or transect distally then do the left gastric, then transect proximally . . . meticulously doing the dissection. It’s interesting to me that when . . . the thoracic guys do this, they essentially just take a white load across the left gastric. Now does that make a difference? I don’t know . . . I do spend a little bit of time doing that . . . It also gives me something to do while the pathologists are telling me about the margins.

In contrast, the chief resident's accounts of various clips were less specific, whether due to inexperience or intention, allowing the coach to interject as opportunities for teaching points arose, eg, "So this is where we're coming . . . underneath the (organ)."

In either scenario, the coach was able to take advantage of the narrative cue and move the discussion forward, providing cautionary words and/or advice:

Surgeon: I always keep my left hand on the mesocolon so that you're separating the . . . mesocolon off of the omentum or the adhesions in the lesser sac.

Coach: I buggered a middle colic one time . . . doing exactly that maneuver.

Coach-driven

Depending on the individual surgeon's level of responsiveness to each, the coach switched between several different techniques of prompting discussion. In the first, reflection was triggered with a direct question, leading the surgeon to realize that he might benefit from changes to his routine practice:

Coach: Why do you stand on the left there?

Surgeon: When I was a resident, the operative surgeon was on the right, and when you graduated to being an operative surgeon, you got to stand on the right, so I always felt like, for the resident, if they are on the left, they felt like they are the assistant . . . Well, actually, you're right. They should be on the left when you are going into the pelvis. And I've got to admit, I've stood on the left so much that I was just more comfortable on the left, and then, when I first started working as an attending, dissecting the pelvis, I had more control if I was on the left.

At times, the same technique required more clarification of the teaching point; the surgeon had to be guided toward a particular thought process:

Coach: So you're above the duodenum taking down the porta? So you're doing that before dealing with the gallbladder . . . Why . . .? . . . You can usually tell a replaced right hepatic by the location with respect to the common bile duct.

The operative attending admitted, "I usually make the tunnel before dividing anything. Probably in this case, I didn't need to do that. We could have taken down the gallbladder."

The coach's second technique used explicit suggestions, and was used most frequently with the chief resident and the junior attending. Noting particular moments on the video, the coach offered alternative approaches. For exam-

ple, on reviewing the chief resident's retractor placement, he advised changes in instrument selection:

Coach: The trouble with using . . . the Richardson-type retractor on the liver is that the angle is such that your hand bumps into it. If you use a malleable, you can fold it back under, and it allows the person working from the patient's left side to get his hand in without hitting your knuckles against the retractor quite so much.

On multiple occasions, the coach proposed a different incision:

Surgeon: Because the tumor seemed to be coming up behind and around it . . . we intended to take the kidney.

Coach: Which does raise . . . the question of whether T-ing off the incision to the right would've been helpful to you . . . If you think that it's all the way around the kidney, then some exposure toward the back there can be helpful.

The surgeon responded that he had been debating this technique, but had "tended to stay midline." Using video replay, the coach highlighted the surgeon's struggle to dissect the kidney to illustrate his reasons for suggesting another incision:

Coach: It looks like . . . you are having trouble at the lower end, and . . . sensing . . . difficulty would make you move to taking the kidney out . . . Having the incision back posterior just facilitates . . . getting the kidney up into the air.

When we followed up with this surgeon, he reported that he had adopted the coach's approach in a subsequent case and found it advantageous.

Feedback was occasionally framed in terms of resident performance; references to the residents who were present in the case, but not present for the review session, eased the discomfort of self-evaluation. As the coach explained it, invoking the resident "makes our interaction less confrontational." He attempted this technique in every session, whether he was making a specific, corrective teaching point:

Coach: When somebody's picking their way through it like this, I always insisted they take up a knife to do it . . . Then they would have what looks to them like a lot of bleeding. It's always lots more than they thought they ought to have, but it's all perfectly minor league stuff . . . Just as a lesson to what you can get away with.

Table 3. Frequency of Appearance of Discussion Topics

Discussion topic	Resident/senior surgeon	Junior surgeon	Senior surgeon	Very senior surgeon	Total
Operative technique					76
Positioning of patient	—	1	1	—	2
Positioning of assistants	—	1	2	—	3
Positioning of retractors	3	6	2	3	14
Incision	4	4	1	2	11
Exposure	7	15	—	10	32
Failure to progress	3	4	6	1	14
Teaching residents	1	—	6	8	15

Numbers represent instances, eg, 10 separate discussions occurred about exposure in the very senior surgeon's session.

or generally fostering a sense that he and the surgeon were colleagues with a common learning goal. Reactions to it were variable. Some surgeons were particularly responsive; once the assessments were directed at their resident's performance, they became noticeably less inhibited, participating more fully in the session and accepting feedback more readily. On occasion, the surgeon expressed frustration with the resident, and the coach, in order to make an effective teaching point, merely had to suggest a solution to optimize the use of assistants:

Surgeon: There were at least 4–5 times that I couldn't see the field because (Resident's) paws were in the way.

Coach: Well, the solution to that is to change retractors, change from self-retaining to assistant-retaining.

The technique, however, was less successful in other instances. One surgeon felt compelled to defend his resident, and was therefore less likely to benefit from the teaching point or the sense of alliance that the coach was trying to create by evoking him. For this surgeon, the coach switched to validation to preface his teaching points. His success is seen in the surgeon's affirmative response, and reflects both the variability in surgeons' responses and the coach's ability to astutely respond to these cues:

Coach: Both you and the resident were very skillful at not wasting time and wasting motions . . . People who don't have their mind made up about where they're going to go and what they're going to do . . . they paw at the tissue . . . You guys clearly had a game plan and went to it. I think this is a wonderful example of that.

Surgeon: Even before we had gotten started . . . we went over the films and said, "Okay, this is what we are going to expose first, and then we are going to work on this part, and this is going to be the hard part." And then, intraoperatively, we just say, "I think we've sort of worn out how much we can do

from there right now. Let's just go to a different area," and we just kept essentially going back and forth (from) the superior to the inferior extent.

Coach: It is helpful to remember to move your traction-retraction.

Surgeon: That's a good point.

Coach: Everybody loses sight of the retractor . . . as they're burrowing forth, away.

Conversational content

Operative technique

Both technical and decision-making aspects of the cases were addressed in the coaching sessions, and were, to some extent, inseparable. The frequency with which each discussion topic appeared is displayed in Table 3. Considerations ranged from the positioning of the patient:

Coach: The other thing that I would have done . . . would have been to put him in Trendelenburg . . . because it just starts getting stuff out of your field.

to the choice and placement of retractors:

Coach: I think (it) is helpful . . . to constantly be changing the Bookwalter . . . You've got stuff down to the right that you don't need, and you need more pull to the left.

Surgeon: So . . . relax on the blades?

Coach: Yeah . . . People don't seem to think of that. They fight it; they think the Bookwalter's going to keep them in one place, exposing everything forever . . . It just doesn't do that.

There was a heavy focus on the choice of incision:

Coach: The concept of having the patient in position or using an incision that might allow you to use the left chest to get at the esophageal-gastric junction is just something (the residents) simply don't think of.

Surgeon: If I needed to do that, I'd probably close and flip, as opposed to crossing the costal margin . . . so in this case, really he was consented for total or subtotal. And even when I do a total in someone of his size (and actually, he lost enough weight that . . . I thought the exposure would be okay) . . . most of the time, I can do that through the abdomen.

and the quality of exposure obtained in the approach:

Coach: You were intraperitoneal, rather than retroperitoneal, on the right . . . You didn't think you needed to take down the left colon to . . . be in the retroperitoneum on the left.

Surgeon: No, because her tumor . . . was coming out of the right retroperitoneum . . . If we just took down the right mesocolon completely, and . . . chased the right colic vessels close to their origin off of the SMA, then I could essentially get at the tumor from that side without having to come all the way into the retroperitoneum and to the left side. Wait, so you would have come in through the (left)?

Coach: The question is: Is it going to be tethered that way by the inferior mesenteric?

Surgeon: I see.

Coach: Is your exposure going to be compromised by the fact that you can't lift it off the aorta because of the involvement of the IMA?

Remarkably, a failure to progress was noted in all cases; every surgeon recognized at least one episode during his case in which forward movement had stalled. As one surgeon described, "Watching it . . . I . . . felt like there was a lot of mucking around." This failure to progress was often pointed out by the operative surgeons themselves, and was obvious to them even when they remembered the case as having proceeded smoothly. This observation accentuates a singular asset of video: it allows one to view oneself in the third person and provides incontrovertible evidence to counteract the inaccuracies of one's memory. In many instances, after a failure to progress was identified, the coach detailed potential maneuvers to resolve the situation.

Teaching

Senior surgeons also tended to use the coach to discuss techniques for teaching residents intraoperatively. The tension between surgeons' competing priorities was addressed; surgeons exchanged tips for inducing desired behavior changes in their residents without compromising care. In the following quote, we see a surgeon explain his method of teaching residents to use both hands when operating, using both explicit instructions and physical reminders:

Surgeon: I tell these guys, "I don't really care what you are doing with your left hand if there's a forceps in your hand, but I want to see your left hand doing things." So often the hand's here, and they're doing this . . . Then I end up pulling my way and using a right angle . . . to try to push it . . .

The value of postgame analysis

Participants universally endorsed the sessions as educationally invaluable. Our coach delineated the unique advantages of using video in allowing surgeons to view themselves in the third person:

Coach: I think there's always a benefit in watching yourself do something because you don't see it as you're doing it. You don't recognize the fumbling and the stuff that you're doing.

This was a sentiment with which both the senior and junior attendings agreed:

Surgeon: I remember that case, and I remember I got to this point, and I wasn't happy . . . Looking at it . . . puts it into perspective.

Surgeon: I don't think there's any operation that you can't do better . . . It's like . . . when I went to tennis camp. The first thing they do is video you serving. You realize, I thought I looked like Nadal, and I don't look like Nadal at all.

Several surgeons underscored the utility in receiving targeted feedback from the coach, particularly for residents and recent graduates. Junior surgeons are likely to need help interpreting their videos, as well as advice to direct their self-improvement, especially when encountering a failure to progress:

Surgeon: With junior faculty, if they are out of their comfort zone, there's a lot of futzing . . . no forward progress . . . You can sort of help people along.

For senior surgeons, the value of the video review session lay in the peer-to-peer interaction, in the way it allowed surgeons to see from a new vantage point. The very senior surgeon likened it to operating with another experienced surgeon—an opportunity for 2 senior surgeons to learn new tricks from one another:

Surgeon: Every time I've ever operated with another senior surgeon, I've learned something . . . a different technique from me or the way they've approached it . . . We don't do that very often.

The coach agreed with this assessment, “I was always interested to learn how people do things and what they do.”

In addition to informing operative surgeons, participants believed this dialogue could serve to advance resident education, whether by exposing trainees to the range of techniques and/or philosophies available to them:

Coach: I think there’s some advantage to hearing the fact that the way (Surgeon) holds his scissors and the way other people hold their scissors is debatable . . . There’s pros and cons about it. And it’s worth hearing that debate.

or by providing a protected time and space to reconcile missed intraoperative teaching opportunities:

Coach: I think all of us just miss those kinds of opportunities . . . (Resident’s Attending) . . . can learn where it would’ve been useful to show (Resident) something.

or by triggering joint reflection between the operative attending and the resident:

Surgeon: I think working with (Coach) and . . . working with residents, saying, “Ok, what’s your reaction? Here’s my reaction,” and, “How could I be a better teacher? How could you be a better student? How could we do this better?” You know, I think that’s healthy.

A caveat was made for junior faculty members; participants believed that resident presence might hinder the candor of a discussion between the coach and a less experienced attending:

Surgeon: I just don’t know whether the junior faculty would be very defensive with residents in there.

Coach: Discussing each little maneuver – as to why you do it, what are the advantages, what are the disadvantages, how would you go about it, what can be done – would be a little more pointed and directed more towards them than it would be with a resident overhearing our discussion.

Finally, participants expressed the opinion that the session was beneficial to the coach as well as the operative surgeon. In addition to its value as a peer-to-peer interaction from which both coach and surgeon may learn, the program provides an avenue for surgeons to maintain a role in surgical education at the end of their operative careers:

Surgeon: It also keeps them pretty involved . . . I think there’s a real value for that . . . There is probably a market for people who are willing to be the coach.

DISCUSSION

Continuous professional development is the new paradigm in surgical education. In contrast to traditional continuing medical education, which, by design, is episodic and aimed at heterogeneous audiences, continuous professional development “emphasizes ongoing professional development of individuals across the continuum of their careers . . . It is learner-centered and self-directed.”¹⁹ It is the endorsed teaching modality of the Division of Education at the American College of Surgeons,^{16,19} yet few interventions that address operative skill in this manner have emerged.

Reznick and MacRae²⁰ advocated for deliberate practice in the acquisition of surgical technique. Only with deliberate practice can expertise be attained; in order to improve performance, one must reflect on his or her own thought processes and actions, and then, in the future, monitor and make specific, intentional adjustments to them. Ericsson¹⁸ held that feedback mediates this self-directed development; it aids in the clarification of thinking and the setting of goals.

Video is among the most effective means of illustrating surgical technique. It is used extensively for technical demonstrations at national conferences, and skills assessments of surgical trainees using video have proven reliable.²¹⁻²³ As a vehicle for allowing one to reflect on his or her own performance, video is unparalleled. It has already been deployed successfully in the delivery of customized feedback to physicians in other settings, improving trauma resuscitation time,^{24,25} epidural placements by anesthesiology residents,²⁶ laparoscopic bench task performance by practicing urologists,²⁷ and residents’ adequacy of exposure and motion efficiency during inguinal hernia repairs.²⁸ Head-to-head comparisons with verbal feedback alone demonstrate the superiority of video-based interventions in sustaining and continually effecting behavior change over time.^{25,26} By providing participants with a third-person view of themselves²⁹ and/or a means of benchmarking themselves against others,³⁰ video seems to mitigate the inaccuracy problems inherent to physician self-assessment; it thwarts denial. One study demonstrated a positive effect of video even without an accompanying review: after gastroenterologists merely became aware that they were being recorded, the quality of their colonoscopies improved.³¹

It should be noted, however, that such a Hawthorne effect will be observed only if the subject is already aware of the modifications needed to augment performance; without someone to help interpret it, the video loses significant meaning. In a study of medical students, verbal commentary from an expert was more effective in improving motion efficiency than self-accessed, computer-generated feedback.³² Our coach picked up on nearly 3 times as many educational cues as the surgeons, a fact that underscores the

tremendous value added by his input to the video alone. Truly constructive feedback can be furnished only by an experienced surgeon, for reasons of credibility as well as knowledge. Indeed, the coaching relationship has similarities to mentorship, a hallmark of the classic Halstedian model of teaching,³³ for which expertise is a fundamental prerequisite. Video-based coaching co-opts the elements of mentorship that are responsible for its ability to effect real practice change: the identification of an individual's gaps in knowledge and/or skill and the sharing of strategies to overcome these deficiencies.^{34,35}

Like mentoring, video-based coaching must be psychologically acceptable to the individual, ie, suitable to his or her concept of self as a professional and a student of surgery. As we have described, the feedback given by our coach was tailored to each surgeon based on learning needs and learning style, and the session was rated as a highly effective educational tool by surgeons spanning a wide range of personality types and professional experience. When we asked our coach about his deliberateness in applying various coaching techniques, he replied that he refined this practice through extensive experience with intraoperative consults. He attributed his success to "not making people feel that they're being judged" and the "fairly light hand, socially" that he has cultivated. Clearly, the success of the program is predicated on the adaptability of the coach, a quality that may be acquirable through training.

Given the small sizes of some surgical practices, we recognize that a suitable coach may not be immediately available in every institution. However, we suspect that a surgeon with the requisite clinical experience—one who is recognized and trusted for his or her surgical knowledge and/or skill—may be found regionally. This surgeon could learn to cultivate the traits necessary for building a supportive, nonthreatening, and constructive rapport with surgeons. With further development, we envision the implementation of coaching programs within established networks, supported by professional organizations, which could provide credibility, as well as infrastructure, to pair surgeons with coaches who have been appropriately trained.

Our initial prototype was one of instructional coaching (also known as expert coaching), in which a veteran consultant helps a relative novice incorporate changes into his/her practice by encouraging self-reflection and modeling behavior.³⁶ However, the sessions shaded toward reciprocal coaching, particularly when the surgeon under review was more senior. The relationship of coach and senior surgeon tended toward bidirectionality, with each learning from the other. The field of education considers both expert and reciprocal styles variants of peer coaching; both coach and trainee are licensed professionals in either situation. As in

education, coaching in surgery must be offered in a non-threatening manner. Peer coaching, based on observation and constructive feedback, is grounded in partnership; it is nonevaluative and nonjudgmental by nature.³⁷ Its use in the professional development of physicians as teachers³⁸ and academics³⁹ has been reported. As our study illustrates, it forms a spectrum from instructional to reciprocal, depending on the experience of the operative surgeon relative to the coach.

Video-based review is highly practical, eliminating many of the inconveniences and risks associated with live intraoperative mentoring. Fast-forwarding confers a time savings of 50% to 80% on would-be mentors without compromising their ability to assess.^{21,22,29} Additional efficiency (and anonymity) may be gained by orchestrating coaching sessions via video conference, as the electronic transmissibility of video lends itself nicely to remote viewing. Concerns about the ethical and medicolegal responsibility of the coach are circumvented, and any sense of urgency or distraction that concurrent patient care may provoke in operative surgeons is removed, allowing them to fully concentrate on their performance. Video demonstrates similar advantages over simulation: it requires little upfront investment in time or expense from operative surgeons or their departments, and the fidelity of the exercise to actual practice is irrefutable.

By the nature of its format, postgame analysis is easily scalable; videos no longer require sophisticated equipment to make, are physically and electronically portable, and are reproducible, ie, may be reviewed repeatedly by multiple users. The program may fill a void in national surgical educational initiatives directed at operative skill. It has the potential to be of particular relevance to surgeons practicing in geographically remote areas and/or within solo practices—those who experience barriers in accessing traditional learning opportunities.

We suggest a number of considerations as surgical coaching programs are developed.

First, context should be provided to aid the coach in putting him- or herself "in the position of the surgeon . . . where I would put the incision, how I would proceed . . . based on my preoperative ideas about the anatomy." Our coach asked specifically for radiologic imaging, as well as an informal, oral synopsis of the patient's initial presentation.

Second, our results indicate that coaching is useful for surgeons at all levels, although the interaction and foci of discussion will likely differ. Junior surgeons may benefit from the insights of an expert surgeon, while more senior surgeons may appreciate the opportunity to see how their colleagues approach a given problem or how teaching may be optimized.

Third, trainees may benefit from the interplay between a senior surgeon and the coach because it illustrates the rationale behind alternative approaches to an operation. Senior surgeons seem secure enough with their performance to not feel threatened by trainee presence.

Fourth, we recommend a video display including both a close-up overhead view of the operative field and a complete view of the operating table in order to give the coach a sense of the surgeons' fine and gross motor movements, as well as of the overall set-up, including placement of retractors and positioning of assistants. Both may be captured by mounting fairly inexpensive camcorders. With even less investment, most institutions may begin by recording laparoscopic cases; such capabilities are generally built into these devices. Audio may be considered as a means of identifying missed teaching opportunities, but might ultimately be deemed distracting to the discussion.

Lastly, although our surgeons underwent only one session each, every one of them believed that it was an educationally valuable experience. We anticipate that coaching is best used longitudinally. With repeated sessions, the coach may refit his or her comments to the surgeon's changing performance, and the intervention may realize its true potential as a vehicle for continuous professional development.

Coaching may be a highly effective method for improving surgical outcomes; however, there are many unanswered questions about this new educational modality. Further investigation is needed to optimize the approach.

Resident involvement was suggested by 2 of the 3 surgeons who did not undergo review with a trainee. We conducted 1 such session, which was well received by all participants. Many of the themes were similar to those invoked by other sessions; however, we believe coaching may be more effective if conducted individually, rather than in teams, particularly if the attending or resident is less senior. As such, we are currently pursuing attending- and resident-level coaching as separate initiatives.

The optimal format for postgame analysis must be determined for each cohort of potential beneficiaries. While we believe all surgeons are likely to benefit from postgame analysis, several subgroups may be of particular interest: recent graduates, remote or isolated surgeons, and surgeons re-entering practice after extended sabbaticals. Each population will likely require sessions customized to its own needs.

Further study is indicated to determine the optimal approach to coaching, including comparisons of the various potential modalities (traditional live intraoperative mentoring vs in-person video review vs intraoperative video

conferencing vs post-hoc video conferencing) and/or participant configurations (individual vs team reviews).

In order for the intervention to be scaled effectively, more evidence is needed about the specific attributes of a successful coach, including those that are baseline prerequisites and those that may be achieved through training. We have described the characteristics of our coach that helped him communicate effectively with a diverse group of surgeons. Further study of coaching provided by other surgeons would enlighten us to a still wider range of coaching techniques and/or surgical topics.

We allowed the postgame analysis sessions to flow organically; we did not direct the content of the discussions or instruct the coach in his approach. Further information about the appropriateness and effectiveness of various coaching topics would aid in streamlining the intervention. Ultimately, our goal is to refine these techniques and topics into guidelines and/or training for would-be coaches to improve reproducibility.

All participants commented spontaneously on the educational value of the session, and some later reported making concrete practice changes based upon it. Further investigation is required into the impact that surgical coaching may have on future performance, preferably using objective metrics related to patient outcomes.

Sachdeva¹⁹ writes, "Frequent low-stakes assessments that are coupled with specific and meaningful feedback should be the hallmark of activities aimed at CPD." Video-based postgame analysis is a novel program that accomplishes just that. It provides a means to transform our daily experience into deliberate practice.

Author Contributions

Study conception and design: Hu, Peyre, Gawande, Greenberg

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