Technology as a Tool to Promote Nontechnical Skills in Surgical Training

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***Abstract*—Surgeons require strong mentorship as part of their training because many of their skills cannot be readily acquired from textbooks; instead, their competence is a result of excellent hand practice. Access to mentors for education in surgical subspecialties is a challenge in many hospitals. Videoconferencing, which enables real-time communication between mentors and mentees at different geographical locations, can overcome this challenge and make the best knowledge available for surgeons in training. This study examines a practice in Norway in which videoconferencing was used to provide education on a laparoscopic surgical procedure. Specifically, the study explores the characteristics of communication between a mentor and mentee using videoconferencing and how this practice allows for both the learning and feedback of mentorship and nontechnical skills. The empirical material consists of video recordings of an educational trajectory comprising eight patient cases and related focus group meetings. Their communication reveals knowledge gaps and their closure through the establishment of a shared understanding. In this way, videoconferencing supported the learning of technical skills while enabling feedback on nontechnical elements. Both the mentor and mentee were able to reach their full potentials, expanding their own communicative skills and reflecting on their own abilities. Videoconferencing also affected the relationship between the mentor and mentee, who were peers and colleagues rather than participants in a traditional mentee–mentor relationship. Hence, videoconferencing practice is an activity that can expand knowledge and be used to evaluate *both* the mentor and mentee, assessing their nontechnical skills in surgical training.**

Keywords—knowledge sharing; nontechnical skills; surgical training; mentorship; feedback; communication; videoconferencing; qualitative study.

I. INTRODUCTION

Although technical skills in surgery are obviously important, communication in the operating room (OR) plays an important role in patient safety because operations are social situations in which tasks are accomplished through communication between team members. The current study focuses on a practice in Norway during which videoconferencing (VC) was used as a tool for communication in surgical education in a specific laparoscopic hernia procedure. The present paper is an extended version of a paper in which we explored the characteristics of communication between a mentor and mentee using VC and how it affected communication [1]. In the previous paper, we concluded that VC supports the learning of technical skills and enables feedback on nontechnical elements. Both the mentor and mentee had the opportunity to reach their full potentials, expanding their own communicative skills and reflecting on their own abilities. Here, the paper extends that previous work, focusing on the use of VC in relation to nontechnical skills, with a view to the use of VC technology for the learning of technical skills [1] [2] but also as an assessment tool for feedback on the mentor and mentee's nontechnical skills relationship in surgical training.

The life of a surgeon is unique and often challenging. Because surgical training requires skills not readily available from textbooks, surgeons in training require a strong guidance from mentors who can transfer their knowledge to them. A good mentor can be the difference between a surgeon who is skilled and fulfilled and one who is merely competent. The changing surgical environment requires a style of mentorship that is distinct from that in other forms of medicine [3]. This paper argues that VC promotes a style of mentorship in which nontechnical skills can be practised and reflected on, thereby placing greater emphasis on these skills in training. Indeed, the quality of collaboration and teamwork allows for improvements in practice beyond technical skills and performance.

The rest of this paper is organised as follows: Section II explores the field of surgical training, Section III describes the theoretical framework of the study, Section IV describes the methods used, Section V present the results, and Section VI presents the discussion. The article ends with conclusions and acknowledgements.

II. SURGICAL TRAINING

Within surgical teams, communication errors have been studied in terms of communication failures [4], and studies have attempted to explain how surgical procedures are influenced by the quality and efficiency of teamwork. Results have shown that deficiencies in teamwork in the OR contribute significantly to adverse events and patient harm [5] because there is a strong relationship between teamwork failure and technical errors [6]. In other words, a good surgeon is more than just a good 'pair of hands' [7]; he or she must be a good team player, must listen and communicate with colleagues and must empower colleagues to reach their full potential [7]. These qualities are related to

collective and cognitive competence, which are defined as nontechnical skills.

Nontechnical skills are gaining importance in surgery and surgical training [7]. The Royal College of Surgeons of Edinburgh defines nontechnical skills as those skills and behaviours related to situational awareness, decision making, communication, teamwork and leadership [8]. Others have defined nontechnical skills as interpersonal (e.g., communication, teamwork), cognitive (e.g., decision making, situational awareness) and personal resource skills (e.g., coping with stress and fatigue) [9]. Communication and teamwork related to decision making are also important nontechnical skills. All these skills are essential for surgeons to operate safely in the OR, and although they are developed in an informal and tacit manner [8], they need to be explicitly addressed in training.

Surgical training involves the individual work and guidance of an expert mentor. Mentees gain significant skills and experience by participating in simulated environments with virtual simulators and models prior to performing procedures on patients in the OR. Work in the OR involves collaboration; each team member has his or her own tasks to perform. Although each team member's individual technical skills are important, good collaboration is necessary for a good surgical outcome [10][11]. Hence, both mentors and mentees need to develop nontechnical skills in surgical training to promote best practice.

Surgical training is an educational process in which the competence and work of both mentor and mentee serve as parts of a collective activity and communicative process. Both communication and teamwork are important for modern surgical education and practice; indeed, a review of the role of nontechnical skills in surgery showed that the key root cause of surgical errors worldwide is a lack of nontechnical skills [6]. The review also provided evidence that nontechnical skills have an effect on technical performance and suggested that training that is focused on improving nontechnical skills can improve teamwork, performance and safety in the OR, thereby positively contributing to patient outcomes [6]. This indicates that there is a need to focus on the development of nontechnical skills in surgical training.

Because surgery strongly depends on a good pair of hands, surgeons in training are dependent on access to mentors with specialist knowledge. This access to local mentors for surgical subspecialties is a challenge in many hospitals. However, in such cases, VC is a technology that can enable real-time communication between mentors and mentees, even if they are in different geographical locations. Thus, it can help to overcome the issue of a lack of access to local experts.

Research on VC has stressed its educational benefits [12] and has described VC for mentoring as an effective way to develop surgical skills [13]. Recently, however, a review of surgical tele-mentoring reported a limited understanding of VC in surgical practice; the review concluded that little attention has been paid to the educational and nontechnical elements and that focus has instead been placed on piloting the technology [12][14]. Within this field, a special focus on communication and team performance is needed to better understand the factors that influence surgical outcomes [15].

Research on communication in terms of feedback between mentors and mentees reveals that supervisors tend to talk about the trainees' actions and their own frames rather than attempting to understand the trainees' perceptions [16]. Consequently, such comments were only loosely tied to the concrete actions of the trainees. To reach the full potential of feedback, supervisors may benefit from training techniques that would stimulate deeper reflection in trainees [16]. This reflects the need to pay attention to communication and feedback as a two-way knowledge process between mentors and mentees, but communication about both mentors' and mentees' work is not that common.

A wider literature search on communication in the OR concluded that further detailed observational research that provides detailed transcripts and analyses of communication patterns is needed to gain a better understanding of nontechnical skills [17]. Addressing this gap, the current study explores communication and teamwork between a mentor and mentee using VC and the knowledge needed to complete the surgery. The use of VC and the communication between mentor and mentee are followed in real-time surgical training through the educational trajectory of a laparoscopic hernia procedure. Even though it is important to gather information about the outcomes of work in the OR, it is also necessary to gain a detailed understanding of the processes and communication patterns that lead to those outcomes. These are often overlooked in favour of technical skills. Therefore, the current study aims to provide insights into how mentors and mentees organise and accomplish collaborative work using VC in the OR by exploring the characteristics of communication in the relationship between them. It also investigates the feedback in the knowledge sharing between mentor and mentee, focusing on the process of nontechnical skills.

The present study investigates knowledge sharing between a mentor and mentee – specifically, the way in which individual knowledge is shared and constructed to ensure that the mentee applies best practices. It expands upon previous work by exploring VC as an assessment tool for feedback on the activity and nontechnical elements in surgical training.

III. FRAMEWORK

Laparoscopy is a visual technique that uses several small ports in the abdomen, with an instrument inserted through each. The procedure is visual because a small camera is inserted into the patient's abdomen. The images obtained from the camera are transmitted to a monitor in the OR but also enable communication with participants outside the OR. In the cases examined in the current article, the mentee and the surgical team used VC to communicate with a geographically distant mentor. The mentee was experienced in surgery and laparoscopy; before practising this procedure on patients, the mentee underwent the traditional education pathway for a new procedure (i.e., simulations using models and videos of the procedure). The mentor was an international expert in this specific procedure. The surgical

training examined in the current study was organised as three onsite sessions in which the mentor performed, assisted with and observed the procedure and five distant sessions in which the mentor and mentee collaborated.

Communication in the OR was framed using an activity theoretical perspective [18], focusing on the complex interactions between individual subjects and their wider context (i.e., educational activities) [19]. Activity theory is a theoretical framework for analysing and understanding human interactions through the use of tools. The mentor and mentee (subjects) were part of a collaborative educational and communicative process (object) mediated by VC (tool). These elements comprise the individual unit of analysis.

Expanding the unit of analysis of education and learning beyond the individual action [20] includes an additional unit: the activity as the unit of analysis. The sets of conditions (rules) that help determine how and why surgeons act as they do and the distribution of tasks (division of labour) among the community of workers (community) frame the human activity as both individual and collective. Rules and division of labour affect the community; through this, the activity can be analysed. Collaborative activity happens between the activity system of the mentor and mentee, enabling the use of VC in practice. VC is thus a tool that mediates social action (illustrated in Figure 1).

Using activity theory as a framework, educational situations are seen as having a significant historical and cultural context, in which the activity of mentor and mentee is hierarchical in nature and culturally and historically located. The activity is the basic unit of analysis used to understand individual actions in a social context in which the outcome is a new expert and local practice.

IV. METHODS

This is an ethnographic study [21] that explores the use of VC for communication between a mentor and a mentee within an educational process. The study was carried out from 2014 to 2016 in Norway and involved observations, interviews, focus groups and field notes. Five semi-structured interviews, which lasted a total of six hours, took place in 2015 and 2016, and all were transcribed and analysed. For three months in 2014 and 2015, surgical training of the mentee in a specific hernia procedure was observed and videotaped.

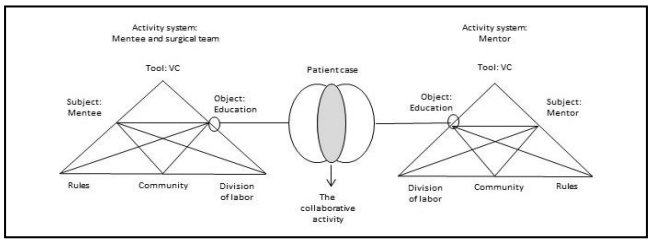

Figure 1. Collaborative activity.

The dataset covers the entire educational trajectory, which includes eight cases and six hours of video observations. The whole dataset was transcribed. All involved participated in two focus group meetings to discuss the procedure. These meetings were also videotaped and transcribed. The mentor was a native English speaker, and the mentee had English as a second language.

The analysis focused on the interactions between the mentor and the mentee, particularly when tensions appeared [21] and knowledge gaps needed to be closed. These interactions shaped the opportunities for expanding verbal decision making and nontechnical skills [22]. The observations in the OR allowed the communication and the team performance to be studied (as opposed to individuals). The eight sessions revealed communication patterns and nontechnical skills (but not individual deficiencies) in a series of operations that utilised VC for educational purposes. The focus group meetings made it possible to study the communication as it arose in the technical performance and reflection.

The study applied for approval from the Regional Committee for Medical and Health Research Ethics, but it was not required for this study. The data-protection officer at the specific hospital approved the study, and all the participants signed an informed consent form.

V. RESULTS

The surgical training examined in the current study was organised into eight sessions. The first three sessions occurred onsite in the OR and involved preparation for the VC, and the next five sessions used VC. After the eighth session, the mentee was considered an expert in this procedure, and the VC sessions ceased [2].

A. Communication using VC

The characteristics of communication using VC are illustrated in Figures 2 and 3.

In Figure 2, we start from the four-minute mark of the seventh session, which was videotaped for about 25 minutes. On the basis of previous sessions, the mentee referred to earlier communication by suggesting a course of action for the day. Specifically, he suggested cauterisation and pulling the sac into the abdominal cavity. He then asked the mentor what he thought about the suggestion (utterance 1). The mentor supported the proposal but had a hunch, based on his own practice with stitches, that simply pulling out the sac would not be adequate (utterance 2).

The mentee referred to the hernia as deep and acknowledged the suggestion to use stitches (utterance 3). The mentor then confirmed that it might be hard to just cauterise (utterance 4). The mentee considered going deep with the instrument (utterance 5), and the mentor elaborated on the depth (utterance 6).

Extract from the seventh session: (A: mentee, B: mentor)

1	A:	I thought maybe today we could try just to cauterise it, if it's possible to – eh – pull the sac out into the abdominal cavity. Or what do you think?
2	B:	Yeah. You can see. You can try. Ehm – it depends. You can try. I always start by turning and, and then if it seems like it's not adequate, then I put a stitch in.
3	A:	It's quite deep, you see …
4	B:	Yeah, it might be hard to do with just cautery.
5	A:	Yeah, I think so to. Because it goes into the …
6	B:	All the way down.
7	A:	Labia majora. Yeah. Okay, I think we will go for …
8	B:	Yeah.
9	A:	I don't think it's even necessary to try. Do you agree?
10	B:	You … but the good thing is, you could do a lot of cautery, you don't have to worry about … Eh ... injuring it.
11	A:	That's good. Okay.

Figure 2. Communication using VC.

After this reflection, the mentee decided to use stiches (utterance 7), a decision that was supported by the mentor (utterance 8). The mentee reconsidered his decision to try to pull the sac into the abdominal cavity and asked the mentor to support this decision (utterance 9). The mentor did support the decision and elaborated on the opportunity to perform cauterisation without injuring the patient (utterance 10). The mentee confirmed that he shared this understanding (utterance 11).

The characteristics of communication in this extract involved skills related to choosing an appropriate course of action and a shared understanding. First, the mentee presented a knowledge gap (i.e., whether to use stiches). This tension between the mentor's knowledge and the mentee's knowledge provided an opportunity to close the knowledge gap, thereby expanding the collective activity of decision making. The mentor supported the suggestion while mentioning the tension between the possible actions (i.e., pulling the sac or using stiches). Drawing on the mentor's experience and knowledge, the mentor and mentee communicated, closing the knowledge gap by establishing a shared understanding. This shared understanding was based on a collective activity in which the participants were able to bridge the gap and perform a successful procedure.

The communication in Figure 3 includes data starting from the 13-minute mark of the eighth session, which was videotaped for about 28 minutes. This extract is a discussion about use of the needle when performing the hernia procedure.

Extract from the eighth session: (A: mentee, B: mentor)

1	B:	You have to go a little bit more medial. So just take the – eh – needle back out a little bit. Then move, and slide in subcuticular (…). Go more medial. Yeah, eh – no, you're too lateral.
2	A:	Still?
3	B:	I can't see the tip of your needle now.
4	A:	You can see it there?
5	B:	Yeah, I think you're … just go … come out of the subcutant a little bit, and just slide the tip of the needle over more medially. Don't be af … Yes, that's better!
6	A:	That's better, yeah.
7	B:	Yeah. Angle it a little … angle it a little more laterally now, so you don't get the epigastrium. Turn it. La … Laterally.
8	A:	It's just – eh – sticking to the peritoneum now.
9	B:	Mhm, just push it, even if it pops out, you can always come back in again.
10	A:	I'm on my way now. There it pops. So, I think maybe just leave the vas.
11	B:	Yeah, I think, I … You're almost there. Just pop, you can pop out.
12	A:	Okay, this was actually one of the – eh – cases that I have learned the most. Because – ehm – the second opening was really tight.
13	B:	Yup!
14	A:	And the thing with the peritoneum vessels and the … it was one of the stickier vasa deferentes I've known.
15	A:	Looks good?
16	B:	That looks great, nice work!

Figure 3. Communication using VC.

The mentor recommends that the mentee move more medially and explains that the mentee needs to take the needle back and out and then slide it in under the skin (subcuticular). Thus, he guides the mentee in the right direction by saying 'go more medial' and 'you're too lateral' (utterance 1). The mentee slides the needle and asks if he is still too lateral (utterance 2). The mentor cannot confirm this because he cannot see the tip of the needle (utterance 3). The mentee moves a bit of the needle under the skin and asks if the mentor can see it now (utterance 4). The mentor, who now sees the needle, recommends that the mentee take the needle back, out of the subcutis, and slide the tip medially (utterance 5). This is a follow-up statement to the mentor's suggestion in utterance 1. The mentee follows the recommendation, and both the mentor and the mentee agree that the method is better than the first method used by the mentee (utterances 5 and 6).

In the new attempt, the mentor guides the mentee by recommending that he 'angle it a little more laterally now' and turn it laterally so that he does not become too close to the epigastrium (utterance 7). The mentee reports that the needle is sticking to the peritoneum (utterance 8). The mentor asks him to push the needle, and by drawing on his experience, he says that the needle can always be brought back if it pops out (utterance 9). The mentee tries to push the needle, and the needle pops out as the mentor said. The mentee suggests leaving the vas (without cauterising) (utterance 10). The mentor supports the mentee about leaving the vas and encourages the mentee by saying 'you are almost there' and recommends that he 'pop out' (utterance 11).

At this moment, the most challenging part of the procedure is over, and the mentee reflects that this case was the one in which he has learned the most from the guidance of the mentor (utterance 12). Since the opening (hernia) was tight, the mentor's knowledge about how to wield the needle was essential for the mentee's method. The mentor confirms that the hernia really was tight (utterance 13) and that the mentee did nice work in this case (utterance 16). The mentee reflects further on why this case was hard: the opening was tight (utterance 12) but also included peritoneal vessels and a sticky vas deferens (utterance 14). The mentee asks if the mentor thinks the result looks good (utterance 15), and the mentor replies 'looks great, nice work' (utterance 16), confirming that the mentee had performed well.

The characteristics of the communication in Figure 3 involve skills related to choosing the right way of using the needle and establishing a shared understanding between the mentor and mentee. First, the mentor offers the mentee knowledge about the method for how to handle the needle (i.e., back and slide in), and the mentee reveals the knowledge gap between his knowledge and the mentee's with regard to the working method. The differences in the methods for using the needle offers an opportunity to close the knowledge gap, thereby expanding the collective activity of decision making. The mentee asks 'still?' and the mentor bridges the knowledge gap by explaining the course of action and establishing a shared understanding. Thus, the knowledge gap is closed through the opportunity to learn a new procedure.

The activity is conducted through the actions of individuals, and by exploring the characteristics of the communication in the relationship between the mentor and mentee, we can obtain insights into how they organise and accomplish collaborative work using VC in the OR. This communication establishes a new work practice.

B. Reviewing the procedure

After each of the eight sessions, the mentor and mentee reviewed the session, as illustrated in Figure 4.

Reviewing a session (A: mentee, B: mentor)

1	B:	I am not sure I like the bend [of your needle].
2	A:	Too much?
3	B:	No, I like it the other way I think.
4	A:	Ah, ok. Yeah, yeah. With all the curve?
5	B:	Yeah, yeah ... Try next time and see if you like it better.

Figure 4. Reviewing the procedure.

When reviewing the session, it came to feedback about the mentee's technique with the needle and how he handled the bend of the needle. The mentor opens up the discussion on the bend of the needle by saying he is not sure whether he likes the bend (utterance 1). The mentee asks if the mentor thinks the bend is too much (utterance 2). The mentor does not refer to the curve of the needle but to an alternative method for handling the needle, 'the other way' (utterance 3). The mentee suggests a method using all the curve length and confirms that he understands that he can handle the needle going with the curve (utterance 4). The mentor verifies that the mentee's suggestion is good and that he can try the other method next time and find out which method he likes best.

Overall, this extract illustrates how the mentor and mentee reflect on their working methods, that is, their technical skills, including methods for using the needle. At the end, the mentor allows the mentee to decide which method he wants to use in his own practice, the mentor's method or the one he performed himself during the procedure.

After the training sessions, focus group meetings was held to review the sessions and allow the mentor and mentee to discuss the content and how VC affected their communication. Figure 5 illustrates how this meeting progressed.

In the excerpt, the mentor asks the mentee about the latter's experience in one of the sessions and how the former could improve as a mentor (utterance 1). The mentee points out the tension between anticipated and 'comfortable' knowledge, referring to the fact that the mentee had watched the training videos of the procedure (utterance 2).

Reviewing two sessions: (A: mentee, B: mentor)

1 B: What was not good? Don't be polite … What could I have done better as a mentor?
2 A: We just assumed that I had seen the video that I knew … You just let me do it, and then you corrected me …
3 B: I didn't give enough instructions (…)? You wish I had given more instructions?
4 A: I don't know if it was necessary, but maybe it would (…) feel more safe, in a way.
5 B: This is a problem that ... Not feeling comfortable as a mentor, knowing not to say too much. When I have a relationship with a resident, I say whatever I want. He is my resident. But when it is a colleague, I am a little bit more shy about being too talkative. Does that make sense? The fact that different relationships exist between me and a trainee, a resident, and another surgeon. I don't want them to be annoyed too much …

Figure 5. Reviewing the procedure.

The mentor asks if the mentee felt that the former had provided too little instruction during the session (utterance 3). Because the session went well, the mentee was not sure whether there was a gap in the knowledge between them but that guidance would have made the mentee feel 'safer' during decision making (utterance 4). The mentor then reflects on the communication between the mentor and mentee, illustrating the tension between the traditional way of locally training mentees (in which the expert mentor holds a more powerful position) and the use of VC as a pre-planned tool for distributed collaborative work, in which the mentor and mentee act as colleagues (utterance 5).

Overall, the extract shows the mentor's and mentee's reflections on their own communicative skills, that is, their nontechnical skills, including how the mentor relates to those around him. By exchanging reflections after the surgical procedure, the mentor was better able to understand his performance as a mentor. This learning activity led to a shared understanding between the activity systems of the mentee and mentor, thereby establishing a new practice for hernia procedures at this hospital.

VI. Discussion

The purpose of the current study was to explore the characteristics of communication between a mentor and mentee using VC in training, and of communication in the feedback about the VC training sessions. By using activity theory as a framework for studying human practices and artefacts in use, the training is understood as a process of development, with both the individual and social levels interlinked. Observing the communication when using VC (Figure 1 and Figure 2) made it possible to identify successful communication and teamwork. This educational process was a collective activity mediated by VC as a cultural tool. Tensions in the work illustrated the limitations of the mentee's individual knowledge, providing opportunities to bridge the knowledge gap between the expert mentor and mentee. Collective decision making led to learning opportunities that allowed the mentee to become an expert in this specific procedure. Thus, communication using VC supported the learning of technical skills.

VC also has the capacity to support collaborative (i.e., nontechnical) skills. The communication examined here refers to previous sessions (a history) and the progress made in expanding the mentee's knowledge. The mentor reflected on his earlier actions and modified his teaching according to the mentee's needs.

The emphasis on decision-making skills in the training allowed the mentee to develop skills related to assessing situations and agreeing on an appropriate course of action within the team. Even though there was a gap in the mentee's knowledge that the mentor had to bridge, the mentor and mentee discussed the options in a balanced way, considering the consequences and benefits of each option and staying flexible while making a shared decision. Afterwards, the mentor explained why he had recommended a specific course of action.

The communication built upon traditional problem-solving in the OR. Laparoscopy is a visual procedure in which a small camera is inserted into the patient's abdomen, and the image is transmitted to a monitor in the OR. In this case, VC was used to show the mentor the same images seen by the mentee. In contrast to traditional training, in which both the mentor and mentee are in the OR, this training occurred using VC. This created tension between the traditional method of local training, in which the mentor and mentee are both at the patient's bedside and are aware of all activity in the OR, and remote guidance, in which the mentor has expert knowledge of the procedure but not complete knowledge of all the activity in the OR.

The problem-solving process is based on the same information, which comes from using the monitor. Consequently, the technical skills are based on the shared knowledge. Nevertheless, there is teamwork in the OR that cannot be experienced by the mentor using VC. Both the mentor and mentee develop awareness of the situation, which includes all the activities in the OR and the pre- and postoperative conditions of the patient. The mentee, who is at the patient's bedside, has the overall picture of the patient. The mentor has expert knowledge and is expected to guide the mentee to deliver high-quality procedures. Thus, because both have great responsibilities, the mentee is more of a colleague than a resident. As the mentor notes in Figure 4, these cases have their own collaborative method that differs from that of traditional mentoring. The mentor acts differently with a colleague than with his own resident, reflecting on what he communicates and trying not to be too talkative and disruptive (i.e., annoying). Using activity theory as a framework, educational situations have a

significant historical and cultural context, such that the activity of the mentor and mentee are hierarchical in nature and culturally and historically located. VC allows the relationship between the mentor and mentee to be more of one between equal colleagues, rather than like the traditional hierarchical mentor–resident relationship. The traditional distribution of tasks and rules are challenged because the VC as a tool mediates social action in a new manner.

When reviewing the procedure, the mentor and mentee discussed both technical skills and the dynamics of the communication patterns (i.e., nontechnical skills). This allowed the mentor to support the mentee while improving his own communication skills through reflection. This activity also supported the mentee in reflecting on his own communication skills. VC was used because the mentee was an experienced surgeon but not in this specific procedure; the competencies of the mentor and mentee were thus unequal in this respect. However, the collaborative activity seemed to affect the historical inequality between the mentor and mentee and redefine the traditional mentee/resident–mentor/expert relationship into one between colleagues. Under the division of labour during surgery, the mentee held the leadership position in the OR, but the mentor was the expert on the procedure. This allowed nontechnical skills, rather than just technical skills, to be developed, subsequently enabling the participants to reflect on how teamwork could be improved.

The use of VC in this setting is not the traditional way of practising training, making it a new tool for this purpose. This may permit more attention to be paid to the problem-solving process and quality than under the traditional way of supervising. Following the trajectory of this training, the team decided to review the technology used to ensure the quality of this supervisory method. This process became more than an evaluation of the technology itself and its capacity for this specific purpose. Reviewing the sessions enabled feedback of the work performed in the VC sessions (Figures 3 and 4). Although it is quite normal to review video films of technical skills during training, it is not that common to include the evaluation of nontechnical activity, that is, the mentor's performance and the communication between the mentor and mentee.

Communication is shaped by organisational culture and historical activities, which play an important role in how work is performed. Communication problems can be attributed to a lack of clarity regarding roles and power relationships [14]. Implementing VC for collaboration in surgical education challenges the traditional surgical training and communication patterns between mentors and mentees. Specifically, the results of the current study illustrate that VC promotes effective reasoning and good communication between mentors and mentees. Communication and teamwork related to decision making are characterised by reflection on the performed work, leading to the development of nontechnical skills and the ability to emphasise nontechnical skills as important in surgical training.

Initially, VC was a tool used to overcome distance. This procedure illustrates how VC has become something more, however, enabling expert knowledge to be shared with mentees who are geographically dispersed. It also illustrates how VC can be used as a tool for feedback on mentorship and collaborative methods. In their study, Entezami et al. [3] called for methods to overcome barriers to effective mentorship, such as a lack of qualified mentors and the lack of an assessment tool to evaluate mentorship in the surgical environment. The present study exemplifies how VC provides a means of assessment for qualified mentors and can educate surgeons, who can then work as mentors for other mentees. In addition, the access to new techniques disperses expert knowledge over geographical distances. Moreover, the current study shows how VC mediates social action, acting as an assessment tool to evaluate mentorship and promote nontechnical skills, encouraging reflection on the communication process. Introducing VC as a tool for communication creates the possibility of offering both traditional and new ways of practising mentorship, enabling the development of an activity for nontechnical skills to become relevant when using VC.

VII. CONCLUSION

In the mentor–mentee relationship studied, contextually embedded interactions occurred between the activity systems of the mentor and mentee. VC allowed knowledge exchange during surgical training, resulting in the mentee becoming an expert in the procedure. The results provide insights into the way in which surgical training and practice are performed, into the communication in training sessions and into the expansion of technical skills.

Because the use of VC as a tool for education in this procedure was new, the surgical team decided to review the technology used to ensure the quality of this method of supervision. This process became more than an evaluation of the technology itself and its capacity for this specific purpose. Reviewing the sessions enabled feedback on the work performed in the VC sessions. The use of VC within surgical training facilitated the development of communication skills because it promoted reflection on both the mentor's and mentee's performance. VC acted as a tool mediating social action, with feedback on the mentee's performance evaluating both the mentor and mentee and assessing the nontechnical skills used in surgical training. The literature has called for an assessment tool to evaluate mentorships in a surgical environment. In this case, VC mediated the evaluation of mentorship and nontechnical skills. Hence, both the mentor and mentee were able to reach their full potential, expanding their own communicative skills and reflecting on their own abilities.

Integrating VC into surgical training within the current training paradigm would allow for both technical and nontechnical elements to be included in the feedback provided to mentees. VC can promote a new style of mentorship in which nontechnical skills can be practised and reflected on while the relevant training is provided. This could be a step towards raising both mentors' and mentees' awareness of nontechnical skills, facilitating changes in the workplace and emphasising collaborative skills (i.e.,

communication and teamwork) in the educational process (and, later, in daily work). In this way, VC could help produce a new generation of surgeons who are competent in all the skills required for knowledge expansion and safe, high-quality patient care.

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