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Original article

Live Surgery: a retrospective study on the outcomes and complications of 7 orthopedic live surgery events

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Abstract
Introduction: Live surgery has always been an invaluable part of medical education. Live Surgery Events (LSE) have recently been criticized in France, arguing that unnecessary risks have been placed on the patients.
Hypothesis: We want to report our experience in organizing the last 7 shoulder LSE over the past 12 years focusing on the results and complications during and after the surgeries performed during these courses.
Material and Methods: 190 patients benefited from live shoulder surgery between 2005 and 2017. 11 of them were lost to follow up, thus 179 patients were included. The mean follow-up was 7,5 years for the instability group, 6,7 years for the rotator cuff group, 7,5 years for

the arthroplasty group and 6,8 years for the nerve group. This study is a retrospective analysis of prospectively collected data. We report the epidemiology of the surgeries perfomed and analyzed the patient outcomes: peri and postoperative complications. We evaluated the educational benefit for the attendees of this shoulder LSE through a questionnaire.
Results: There were 6 (3.1%) peri or immediate postoperative complications. There were 33 (18%) long term complications needing 26 (14%) revisions. 90% of the surgeons audience attending the events evaluated the educational benefit from good to very good.
Discussion: Over the years, we have standardized the organization of the meeting to ensure maximum safety, while still respecting patient integrity and anonymity. Our complications rates seem within the ranges found in the current literature for each procedure. Our LSE has been an instrument for education, but also for matching patients with complex problems with experienced surgeons, to the benefit of the patient. Our experience has shown that LSE may induce potential dangers and complications can arise. However, these events should follow rigorous rules and not just recommendations.
Level of evidence: IV; retrospective analysis of prospectively collected data
Key Words: Shoulder surgery, research ethics, patient privacy, live surgical broadcasting, education

Introduction

Live surgery has always been an invaluable part of medical education starting with anatomical theatres in late 16th century in Europe [1] to procedures being performed in front of an audience in medical universities [2]. Recently, the scope of surgical demonstrations has increased significantly with advances in audiovisual technology and minimally invasive surgery. The development of arthroscopic surgery has been an important part of this evolution. Live Surgery Events (LSE) provide the opportunity for expert surgeons to share their knowledge with the audience and show how they deal with complications in real time. LSE also have an educational perspective and enable the broadcasting of high definition images all over the world.

Many factors affect the risk-to-benefit ratio of live case presentations in LSE [1] especially the surgeon's anxiety due to the large audience and the higher level of distraction for the supporting staff during the procedure. The primary surgeon must maintain a continuous dialogue explaining exactly what he/she is doing and the reasons for choosing a particular technique. Occasionally, the surgeon may be interrupted by questions from the audience which can be distracting and can detract from optimum surgical management. The staff can be unfamiliar with a potential language barrier when international surgeons are involved in the LSE. Also, the operating room is frequently cluttered with additional equipment and personnel who are necessary for the audiovisual production. Moreover, LSE may induce an unnecessary and harmful delay in treatment, if the indication for a particular surgical procedure is considered ideal for a live demonstration at a conference, which has been scheduled for a future date [3].

Every two years, since 2005, our facility has hosted an orthopedic live surgery. Internationally renowned shoulder surgeons perform different procedures that are broadcast live in a conference room for the purpose of educating viewer in attendance. These LSE have recently been discussed in the French media, as a part of the surgeons population suggested that risks may have been placed on the patients, and the organization

of LSE should be standardized [4]. We decided to report our experience and evaluate our results in surgery during the last 7 LSE meetings organized at our institution over the past 12 years focusing on the results and complications during and after the surgeries performed during these courses. The main objective of this study was to report our experience, through the patient outcomes: peri and postoperative complications. The secondary objective was to evaluate the educational benefit of this LSE. Our hypothesis is that we were able to organize numerous LSE, in a controlled environment regarding safety of the patients, and providing outcomes similar to our regular practice.

Methods

This study is a retrospective analysis of prospectively collected data. Outcomes were reviewed post operatively via clinical database assessment.

The course

Since 2005, we have organized our Live shoulder Surgery Course every two years. During each 3 days event, live shoulder surgeries were performed by French and international surgeons. All procedures were broadcast to an auditorium where 500 to 800 surgeons were in attendance. All surgeries were performed with live commentary and discussion between the audience and 2 moderators, present in the conference room, who could interact through direct communication with the operating room.

Over the years, we adapted our practices to the guidelines published by the different societies. The courses were approved by the American Shoulder and Elbow Society, the AGA Patronat Gutesiegl, the Spanish Arthroscopic Society, the Chinese shoulder and Elbow Society, the Italian Arthroscopic Society, the European Society for Surgery of the Shoulder and the Elbow, the French Arthroscopic Society, the French Society of Orthopedic Surgery, the French Shoulder and Elbow Society.

Patient anonymity was respected at all time. No personal data other than the medical information useful for each case was reported to the audience. All procedures were recorded to be used for educational purposes.

The host surgeon and the clinic took out a special insurance policy, to cover the guest surgeons and themselves, in case of complications and legal litigation.

In terms of fees, there were no added costs for the patient.

There was no conflict of interest in any kind for the surgeons involved.

Patient selection

Our inclusion criteria were all patients who underwent surgery during our LSE between 2005 and 2017. Our exclusion criteria were the patients followed in other centers for whom we had no postoperative data. The patients were split into 4 categories of procedures: the instability group (anterior and posterior Bankart, Latarjet, posterior bone block, revision of anterior bone block, acromioclavicular stabilization, SLAP lesions), the rotator cuff group (repair and tendon transfer for irreparable rotator cuff tear), the arthroplasty group (anatomical, reverse shoulder arthroplasty, revision of shoulder arthroplasty) and the nerve group (plexus release, suprascapular nerve release, tendon transfer for trapezius palsy).

Evaluation of the results and complications

The primary endpoint was the incidence of perioperative and postoperative complications. Complication rates were reviewed on the clinical database. All patients followed up either at our facility with the primary surgeon or in another center with the surgeon who operated on the patient during the course. Any complications or deviations from the planned treatment course were documented for each surgical group. We also examined the long-term

complications and reoperations. We separated complications into two categories that were defined as immediate peri operative, and long-term complications. Long term complications were organized as minor and major complications. Peri operative complications included wound infections, hematomas, neurologic impairments, and any types of event occurring in the short term post-operative period requiring early re operation. Major complications were defined as complications that occurred in the first 12 months and required a complex surgical revision. (i.e. procedures that required a full revision of the procedure performed initially). Examples of these including revision for recurrent instability after a latarjet procedure or revision of a prosthesis for dislocation after shoulder arthroplasty. Minor complications were the complications that occurred more than 12 months post operatively and were either routinely expected complications (i.e. implants loosening), complications which did not require further intervention or complications which required a minor intervention (i.e. hardware removal or suture trimming).

In our series, we evaluated the conditions of security and safety for the patients. We investigated the way invited surgeons were informed about the cases they were to perform. We also studied the interaction between the local team and the guest surgeons.

This was a descriptive retrospective study. Continuous variables were expressed as means and ranges. Categorical variables were expressed as numbers and percentages. No comparisons were done.

Evaluation of the educational benefit

All participants were invited to participate in a survey using a questionnaire at the end of each meeting, in which several parameters including the educational benefit, the quality of the meeting and the quality of the procedures could be rated using a Likert scale (from very good to very poor). From the available data, which included complete and some partially completed surveys, we compiled the participants answers and opinions.

Results

Organization of the meeting

All the patients scheduled for the courses were selected by our team. Surgery was indicated regardless of the patient's participation in the LSE and optimal treatment was the priority in all cases. No emergency treatment was delayed because of the LSE. Critically ill or very old patients were excluded from the LSE, to avoid any additional risk. Patient selection was based on a combination of cases commonly seen in practice consisting of primary and revision procedures (rotator cuff surgery, shoulder instability and shoulder arthroplasty) and complex cases.

All patients agreed to participate in the LSE and gave written consent for both the surgery and the transmission and recording of the surgical procedures. They were informed and consented to the possibility of undergoing surgery by a member outside of our team. Presentation of all patient data and all video transmissions were strictly confidential. Detailed patient information (medical history, videos of the clinical exam, radiographic images, etc.) were sent to all surgeons before the procedure to assure good preparation. Each procedure was performed by a team consisting of the main surgeon, usually one of the invited international surgeons, and a secondary surgeon from our facility who could assure the postoperative care and who was responsible for the patient, pre, peri, and postoperatively, who ensured the quality of the surgical preparation, the communication with the local team, and was at any time during the surgery able to manage perioperative complications and if necessary take the lead during the case. Each patient met the two surgeons and had a preoperative clinical examination by both of them to confirm the

indications for surgery. Both surgeons saw the patient after the intervention. Postoperative treatment in general was determined by the main surgeon. The main surgeon received information of postoperative complications and outcomes on the patients of which they operated.

Management of visiting surgeon preferences and foreign operating room setting

The operating surgeon submitted in advance a detailed list of preferences, including instruments, disposables, and devices. Included was a spatial positioning request for the operating room with regards to the patient, surgeon, and scrub nurse positioning. The surgeons also met the anesthesiologist before surgery to validate the type of anesthesiology, and a circulating nurse to check the set up and equipment. All surgeons ensured that their clinical practice schedule allowed them time to arrive sufficiently in advance of the session to prepare for the procedure and to operate under normal conditions of mental concentration.

All usual hygiene and safety precautions were respected: sterility, confinement of the room (no unnecessary entry/exit, restricted staff only), pre-incision checklist/time out completed by both of the surgeons, non-medical equipment decontaminated, respect for patient confidentiality, control of all intraoperative communication during the intervention.

The staff at our facility was experienced in all the procedures. There were two skilled moderators in the conference room to avoid distraction and to select the relevant questions from the audience to ask operating surgeons at the appropriate time.

Patients characteristics

190 patients were operated on between 2005 and 2017. 11 of them were lost to follow up, thus 179 patients were included. The mean follow-up was 7,5 years for the instability group (□=3,9, min=2, max=14), 6,8 years for the rotator cuff group (□=3,9, min=2, max=14), 7,5 years for the arthroplasty group (□=3,7, min=2, max=14) and 6,8 years for the nerve group (□=6,4, min=2, max=14). The patients' characteristics are depicted in figures 1, 2, 3: 43,9% were women. The average ages were 39 years old for the instability group, 59 for the rotator cuff group (reparation or tendon transfer), 42 for the nerve group, and 67 for the arthroplasty group. The 4 groups characteristics are depicted in Table 1.

64 patients were treated for instability:

- 24 for arthroscopic anterior Bankart repair
- 3 for arthroscopic posterior Bankart repair
- 5 for arthroscopic acromioclavicular joint stabilization
- 19 for Latarjet (12 arthroscopic, 7 open or mini open)
- 6 for arthroscopic posterior bone block
- 5 for revision of anterior bone block (4 arthroscopic, 1 open)
- 2 for arthroscopic SLAP lesion repair

57 patients were treated for rotator cuff disease:

- 43 for arthroscopic rotator cuff repair (23 posterosuperior tears, 8 subscapularis tears), including 12 massive rotator cuff tears (10 posterosuperior tears, 2 anterosuperior tears)
- 14 for tendon transfers for irreparable rotator cuff tears (1 lower trapezius + latissimus dorsi transfer, 1 pectoral major transfer, 12 latissimus dorsi transfers)

64 patients were treated with arthroplasty

- 31 for anatomical shoulder arthroplasty
- 27 for reverse shoulder arthroplasty (including 4 with latissimus dorsi tendon transfer)

- 6 revisions of shoulder arthroplasty (including 1 with latissimus dorsi tendon transfer)

5 patients were treated for nerve pathology

- 2 arthroscopic plexus release for thoracic outlet syndrome
- 2 arthroscopic suprascapular nerve release
- 1 triple transfer for trapezius palsy

Surgeries performed

Table 1 shows the different procedures performed at the LSE meetings between 2005 and 2017. Fifty different surgeons, detailed in table 2, operated at the LSE meetings. Twelve surgeons performed more than four operations at our LSE (experienced live surgeons), while most surgeons performed once or twice (median 2). All surgeons provided consent to be named in this study.

Complications (Figure 4)

There were 6 (3.1%) peri or immediate postoperative complications:

- 1 humeral fracture on a revision shoulder arthroplasty
- 4 temporary nerve deficits (3 in anatomical arthroplasties, with a full recovery in less than 6 months, 1 in an arthroscopic plexus release, with a full recovery in 3 months, 1 in a latissimus dorsi transfer with a full recovery in 6 months)
- 1 plexus palsy followed by partial recovery in a latissimus dorsi transfer
- There was no wound infection or hematoma.

There were 33 (18%) long term complications needing 26 (14%) revisions:

- 17 long term major complications (9%)
- 16 long term minor complications (9%).

All the complications are detailed in tables 3 to 9.

Conference Participation Survey

Fifty-four percent of the participants answered to to the questionnaire. Ninety percent of them rated the quality of the surgery from good to very good, 94% evaluated the quality of the moderation from good to very good, 87% evaluated the quality of the live broadcast from good to very good, 90% evaluated the educational benefit from good to very good.

Discussion

Live surgery has been part of medical education for centuries. Technological advances in video broadcasting have made it possible to move from surgical amphitheaters to live video transmission around the world in the last few decades. Different factors have led to discussion surrounding LSE, specifically patient safety during the procedures. These factors can be scrutinized: the jetlag experienced by guest surgeons, the language barrier, the new team (anesthesiologist, nurses, assistants), the unusual equipment and set up, the pressure of live and performance, the interruptions from the audience which can alter the operator's concentration and threaten the flow of the operation.

With these concerns in mind, several surgical societies allow LSE only if specific guidelines are followed. The European Association of Urology and European Society of Gastrointestinal Endoscopy, have a standardized policy statement regulating LSE within their organization [3,5,6]. Some organizations have banned live surgery events altogether, such as the Japanese Society of Thoracic Surgeons who put a stop to live surgery in 2006, when a patient died after the repair of an aortic aneurysm [7].

In orthopedic surgery, Liverneau [4] pointed out in his book that there are no standard regulations for LSE, which he believed could lead to perioperative incidents.

The first sessions of our LSE began without clear recommendations from any of the orthopedic societies. Over the years, we have standardized the organization of the meeting

to ensure maximum safety, while still respecting patient integrity and anonymity. A few years ago, we took part in the development of the French orthopedic society's guidelines for live surgery described in appendix 1, based on our experience. These standardized guidelines included recommendations on patient selection, informed consent, and surgeon selection. Indeed, many of the procedures performed at our LSE were difficult, advanced and/or salvage procedures (triple transfer, revisions of malunion, etc…). We selected expert surgeons from all over the world, recognized for their skills in complex cases, and provided assistance using the local surgeons, who would most likely be following the patient through the postoperative course. The level of complexity of the procedures may explain why our peri- and postoperative complications rate seems high, although it seems similar to our current practice. Our complications rates seem to be within the ranges found in the current literature for each procedure, despite the fact that this statement follows an impression, and not a thorough randomized study with a control group, thus not providing strict statistically valid conclusions. For the instability group starting with bankart repair, including major and minor complications, our complication rate was 17% (5/29). The current literature range of complications for bankart repair is 10-55% [8,9]. For Latarjet procedures both open and arthroscopic, our complication rate was 30% (7/22) and the range for the current literature is 4-30% [10–13]. For posterior stabilization, our complication rate was 66% (4/6) with the current literature range being between 36-72% [14]. For arthroplasty, our complication rate was 20% (12/61) and the literature rates range from 5-42% [15,16]. For the rotator cuff repair group, our rate of complication was 20% (8/41) and the literature rates range from 2-30% [17–19]. For tendon transfers, our rate was 14% (2/12) and the literature rates range from 10-46% with variable rates for specific transfers [20–23].

It's interesting to think about the management of perioperative complications. Should the transmission be stopped or is the management of these acutely stressful situations one of the major interests of live surgery. In our experience we have been confronted with a perioperative fracture during a shoulder arthroplasty revision. We decided to stop the live broadcast and interactions with the audience until the critical phase was resolved. The rest of the video was shown at the end of the procedure. The other immediate complications were nerve palsy managed according to the recommendations of good practice (neurolysis in cases where there was no spontaneous recovery). The same applies to long-term complications that benefited from conventional management: surgical revision (Latarjet after Bankart failure, Eden Hybinette after Latarjet failure, reverse shoulder arthroplasty after implant loosening of an anatomic arthroplasty, etc.) or non-surgical management: physiotherapy, etc. Our main concern is the patient's well-being, and with that being said we consider that the patient's risks are unchanged by having live surgery compared to our regular clinical practice.

In 2019, we interviewed patients, in an informal setting, who were operated on during the most recent course. This was done at a follow-up consultation to ask about their experience with being a part of a live surgery event. None of them experienced added stress and all reported feeling confident and well cared for. They felt well informed about the ins and outs of the meeting and said they would repeat the experience if presented with the same situation again. Three patients had surgery twice at different courses by the same guest surgeon: two patients had surgery on the contralateral shoulder and one patient had a revision after poly wear in a total shoulder arthroplasty.

The local team's feeling at the end of these events was generally good indicating that local surgeons, fellows, paramedical staff found the experience rewarding. Indeed, meeting

international and renowned surgeons, comparing different practices and habits, exchanging in English was perceived as very formative. The high level of timed organization during LSE in the operating theatre can often be considered an additional stress, but it has allowed the local staff to reconsider the daily organization for more fluidity and speed between operations. Our organization benefits from this experience in our daily practice. The guest surgeons also provided good feedback, both in terms of their opportunity to operate on interesting cases, and the pleasure of sharing their experience and knowledge with the large audience. The debriefing organized at the end of the operating day or the next morning allows everyone to discuss the surgical techniques and to benefit from the feedback of all participating surgeons and staff.

In urological surgery, Finch and al has shown that “as live broadcast” offers similar educational opportunities to delegates when compared with « live surgery broadcast, while appearing to offer significant welfare benefits to both surgeon and patient [24]. It would be interesting to ask the course participants if they feel that this live surgery is more instructive than videotaped surgeries.

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Study limitations

We acknowledge this study contains limitations. Our results must be presented and analyzed with thorough care and humbleness.

Given this is a report of data from a single institution that broadcasts a high number of surgeries in a short period of time as well as given many international surgeons are participating, this may not be a fair comparison.

As a matter of fact, this is a retrospective observational study, and we did not perform any literature meta-analysis enabling a statistical comparison with the complication rates described in the group of patients operated during LSE. Furthermore, we did not provide any analysis of our usual complication rates, in an everyday life practice enabling to conclude whether it was higher or lower than during LSE, we did not have any control group and analyze a small number of patients. However, our aim with this study is to report our experience remaining honest and transparent regarding the complications encountered.

Another major issue concerns the bias in reference to the quality of the surgeons involved in these events, and the experience of the organizing committee. As an important aside, our findings also may not generalize well to all live surgery events. One must ask if these complications could have been avoided under normal circumstances not in a live broadcast event for these complex procedures. The experience of the surgeons performing the operations should also be considered in this analysis.

Reader must be aware that such an event may be difficult to reproduce on a local basis, and our message is not to assert that these are easy and safe to organize. Indeed, the surgeons involved are well known, famous, experienced surgeons, most of them familiar with live broadcasting, thus limiting but not excluding the pressure they are able to endorse while performing. On another note, at the beginning of the experience of organizing such events, the procedures showed were simple ones (i.e. calcic deposit removals, acromioplasties, simple cuff repairs) and this permitted to build an experience broadcasting. The experience acquired in this field does not only concern the chairman, surgeons, and technical teams, but also the operative theatre managers and workers. We therefore concede that it seems important to perfectly regulate the organization of LSE when a center decides to create a first event in its structure. Nonetheless, regulations exist, and were created with the growing

experience and development of LSE, ensuring security and safety to patients involved in those events, provided that organizing staff respects those rules.

Conclusions

To our knowledge, this is the first follow-up of live surgery event in the field of orthopedic surgery. Considering the debates currently surrounding LSE, we considered it mandatory to have an objective evaluation of the patients who underwent surgery during our LSE over the past 12 years. We were able to show that our rate of complications in general was lower than the current literature. Our LSE has been an instrument for education, but also for matching patients with complex problems with experienced surgeons, to the benefit of the patient. We were able to always keep patient safety our priority, not straying from that of everyday practice.

Our experience has shown that LSE may induce potential dangers and complications can arise. However, these events should be well organized, and follow rigorous rules and not just recommendations, just as in daily surgery. With proper precautions and attention to detail, complications rates should not be higher than in normal practice.

Surgical and medical practices should always strive to improve. Techniques can continue to evolve by adapting the best methods for the delivery of knowledge and teaching. We therefore believe that LSE, along with simulators or augmented reality have a role to play in the training of future surgeons. However, it cannot replace the experience and knowledge that an older, more specialized surgeon can convey in the live surgery setting. In the end, live surgery events will benefit the patients, who will be treated by better surgeons thanks to their attendance and experiences at live surgery events. And those surgeons will be able to adopt learned techniques and hopefully improve on how they handle tough cases and complications, not just from being told how but because they were shown how.

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Disclosure of interest

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Marie PROTAIS : second author, data collection, manuscript writing, editing
M. Christian MOODY : data collection, manuscript editing
Manon COLAS : data collection
Ken Lee PUAH : data collection
Thibault LAFOSSE : last author, project development, data management, manuscript writing / editing

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