The Potential of the ICUC® Documentation Concept to Improve Trauma Surgery

Potenciál ICUC® koncepce dokumentace pro zkvalitnění traumatologie

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SUMMARY

Conventional documentation of surgical procedures using only pre- and postoperative X-ray images and possibly a few intra-operative pictures does not allow secondary analysis of the technical performance in detail. In particular, the quality of the handling of tissues and surgical tools cannot be judged «post hoc», i.e. after the end of the surgical procedure. The invasiveness of the surgical act cannot yet be quantified. Surrogate invasiveness indices have therefore been developed. Furthermore, conventional documentation does not allow evaluation of the proper use of the C-arm both technically and with regard to fluoroscopy time. Documentation that follows the ICUC® documentation concept includes all fluoroscopy shots and images covering all key portions of the entire surgical procedure by multiple still images or videos. In certain cases, such documentation can help to explain post-operative courses that might be difficult to understand based only on X-rays and written operation reports. Finally, the data included in ICUC® documentation are a valuable source for knowledge extraction. In addition, time saving is conceivable if operation reports can include images of the key stages of the procedure with a few additional comments dictated during the surgery.

Key words: trauma surgery, ICUC® documentation concept.

THE PROBLEM

Today's documentation of surgical fracture treatment, which includes a report, pre-and post-operative X-rays or CTs and possibly some additional intra-operative images of the surgical field, is open to improvement. This standard documentation does not provide realistic information about the fundamental aspects of technical performance. As examples, we mention technical difficulties encountered, biological aspects, i.e. the quality of soft tissue handling by the surgeon or the radiation absorbed by the patient and the surgical crew.

The skills of musculo-skeletal surgeons and especially their tissue handling are often said to be extremely important (13, 15) , but they are not documented and not enough effort is made to assess them. Based exclusively on a written report it is retrospectively impossible to judge how much tissue trauma was produced by the surgery especially if pre- and post-operative X-rays are the only additional documents on the procedure. In the future, we might be able to quantify the tissue trauma produced by the surgery biochemically (3, 4, 9). While waiting for such tests, surrogate surgical invasiveness scores have been developed to obtain a « post hoc» quantification of the surgical trauma (10). As of now we can only try to document the procedures with photographic recordings that allow us to estimate the additional tissue trauma caused by the surgery. Improper handling of tissues and technical tools is a frequent source of complications or difficult post-operative courses, not only concerning the skin but also the deeper soft tissues and the bone. As these elements are not usually documented, it is often difficult to understand why complications occurred.

The ICUC® documentation concept and the potential of its application

The "ICUC® study group" has developed an "orthopedic trauma app" (5). This app is the product of the application of the more generic ICUC® concept in the field of learning, The goal of ICUC® is to mediate new insights by adding missing information about hitherto undisclosed aspects of surgical performance. The improved knowledge is collated through extended case analyses of bone biomechanics and biology with their determining effects. Especially addressed are the effect of surgical handling on the biology of the tissues involved, namely the soft tissues with their blood supply to bone and their effect on the biology of repair and of bone.

Assessment of the complete intervention may be gained from continuous video recording. While videos offer the desired information, video recordings require inexpedient scanning of hours of recording and are therefore inefficient and impracticable. Recording the critical steps of surgery, namely of those activities which deviate from the planned procedure, would comply with the requirement of improved information. Two approaches to capturing the critical steps in surgery were considered: either recording video clips or still pictures. Once the critical steps are defined still pictures offer proper information and allow efficient retrospective scanning. The touchy point consists in the selection of the critical step. Either the surgeon himself or a photographer who is competent in the surgery involved may select and record the critical steps. The two procedures offer advantages

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and shortcomings. We selected the second procedure as it delivers the appropriate information in compliance with the main objectives and the need for complete information. The more demanding procedure was judged preferable at the present stage of the development. It offers the essential data required for retrospective studies that are considered to provide relevant data to increase understanding and potentially avoid complications in the future.

The ICUC Trauma App

The ICUC trauma app (5) is a learning tool. It is based on the documentation of prospective surgical series and includes multiple still images of the procedures. Different hospitals record all trauma cases during predefined periods. The latter keeps the expenditure and demands within tolerable limits. Video-animations and expert comments improve the learning experience. The app is an electronic learning tool and therefore permits the inclusion of details and a data volume that printed reports cannot match.

Radiation hazards, although accepted as relevant, are usually underestimated (2, 6). The ease of intra-operative fluoroscopy exams facilitates attempts to improve suboptimal fracture reduction without undue time loss. However, ignorance of correct C-arm handling and a casual approach (e.g. not keeping a proper distance from the radiation source) often results in a too generous or inadequate use of the C-arm. The ICUC® app displays fluoroscopy times and thus helps to reduce radiation if the surgeon masters the handling of the C-arm and knows standard settings. The data provided by dosimeters is supplemented (6, 14).

The following selected images illustrate the above assertions.

Examples illustrating the value of an ICUC® app-type of intra-operative documentation and its use for knowledge extraction

1. Surgeon's tissue handling

Fig. 1. Minimally invasive plating of a tibia fracture This almost "non"-displaced fracture could also have been treated conservatively. The complete documentation shows that the invasiveness of the plating procedure has been minimal. In contrast, the use of the descriptive term «MIO- plating» in an operation report does not guarantee gentle soft tissue handling. Case extracted from the ICUC app, ICUC 42-WE-608/20y.

Fig. 2. More invasive tissue handling. In contrast to the case of the previous case in Fig. 1 much more manipulation was needed in this case. The individual X-rays do not document this important aspect. The use of cerclages, even with minimally invasive techniques, is controversial in the tibia. Case extracted from the ICUC app ID 42–SI-563/35y.

2. Overcoming the insufficiencies of conventional surgical reports

Today's requirements for the documentation of surgical procedures are very limited. Patient data, diagnosis, name of the procedure, findings, specimen removed and estimated blood loss have to be written immediately or within 24 hours and duly signed with a date prior to moving the patient to the next level of care. Written reports on surgical procedures are time-consuming and have many potential defects: They can be too short or too long, they can omit relevant happenings or simply not allow a detailed understanding of what has been done during the procedure. Missing details can impede an understanding of certain complicated post-operative courses so that ultimately processes and procedures are not improved.

Reports could be less time consuming and more informative if photographic images were used and additional comments made during the operation. The world of endoscopic surgery seems to have evolved further in this respect: There are surgeons who routinely achieve their videos and in certain geographical areas there are legal constraints to do so.

3. Radiation assessed by the ICUC® app

Looking only at the postoperative images of both cases (Fig. 5 and Fig. 6) they seem very similar. The difference in the radiation dose does not appear. Only complete documentation of all C-arm shots allows to scroll through and appreciate the relevant and significant differences.

Repetitive C-arm shots are justified to check and improve reduction. Care must be taken to limit radiation both to the patient and to the surgical crew. Correct positioning of the C-arm is part of the planning. Thereafter, the relative position of the surgical crew is crucial with regard to radiation absorbed (Fig. 8 and Fig. 9).

DISCUSSION

Today's legal documentation requirements do not ask for any image documentation (8). Only a full description of the procedure including the indications and intra-operative complications is required. An ICUC® app type documentation, as described in a previous publication (12) and partially illustrated in the cases above, is far more comprehensive, but is not simple to realize. Many *organizational prerequisites* must be fulfilled and accepted by the surgeons responsible and managers of the documenting hospitals: The documentation must be done by i*ndependent documentalists* with a great number of still images or with videos. A full video-documentation poses the problem of handling and of data volume. Still images are easier to scroll through and facilitate finding the desired image. A mixture of still images and short video clips for the essential stages of the procedure is optimal. An *independent auditor* guaranties the implementation of the ICUC documentation rules for completeness and follow up. *Anonymity* of the data is necessary to protect the patient and the surgeon. The documentation data set forms the basis of the ICUC app as a *learning tool (12)* from which the examples shown above have been extracted. The app illustrates the advantages for learning and offers interesting *material for knowledge extraction (11)*. Applying the ICUC documentation concept to all surgical procedures performed would be very demanding. Therefore, it can be limited to selected, frequent «tracer diagnoses/procedures»[4]. Thus, it would provide valuable data for modern quality control/management (1). Furthermore, time constraints of surgeons could be diminished if reports consisted of images and a few comments dictated during the surgery.

[4] Tracers are selected indicators upon which the strength and weaknesses of the treatment and care processes used are evaluated. A tracer diagnosis must be frequent, reproducible and scientifically generally applicable.

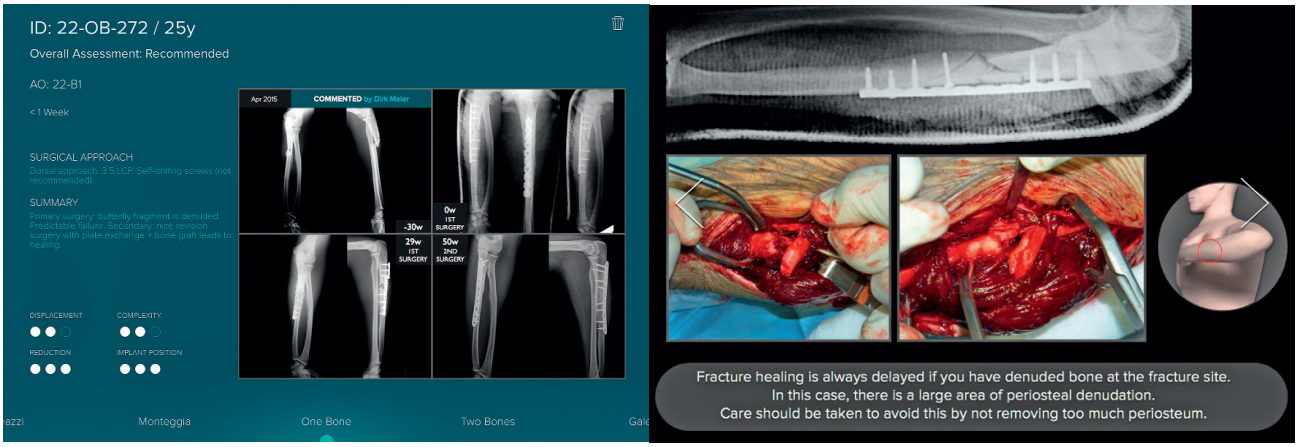


Fig. 3. Plate fatigue after plating of a complex ulna fracture (details ICUC app, forearm, one bone, ID 22-OB- 272, overview and image 5/160).The evolution can be better understood, if we have an intra-operative documentation (right image) showing a completely denuded third fragment. Analyzing and understanding complex or even complicated post-operative courses ultimately allow processes and procedures to be improved.

Fig. 4. Two very similar cases (matched pairs) of distal radius fractures fixed with volar plates. Significant difference in the radiation used. (Both cases are ICUC cases.) The case on the left is already in the app (ID 23-DC-613), the case on the right is also an ICUC case that will be included with the new case series.

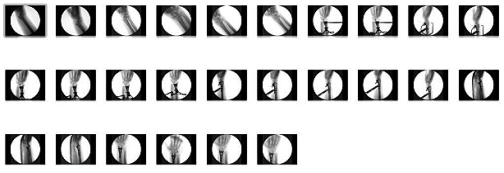
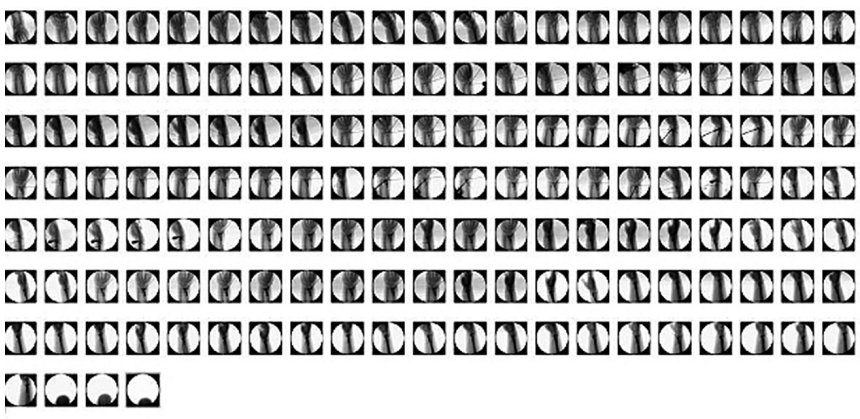


Fig. 5. C-arm shots used for the case on the right in fig 4: 26 C-arm shots seem adequate considering the complexity of the fracture.



Finally, the quality of scientific publications could be improved by adding the above-mentioned data for every single patient, e.g. as a footnote or in the appendix. This would conform to the requirements of the Cochrane library for pharmaceutical trials (1, 7). Clearly, this could only be realized in an electronic format due to the resulting large data volumes.

Fig. 6. C-arm shots used for the case on the left in Fig. 4. The number of 151 C-arm shots reflects the difficulties encountered, resulting in a less good reduction, compared to case on the left of Fig. 3.

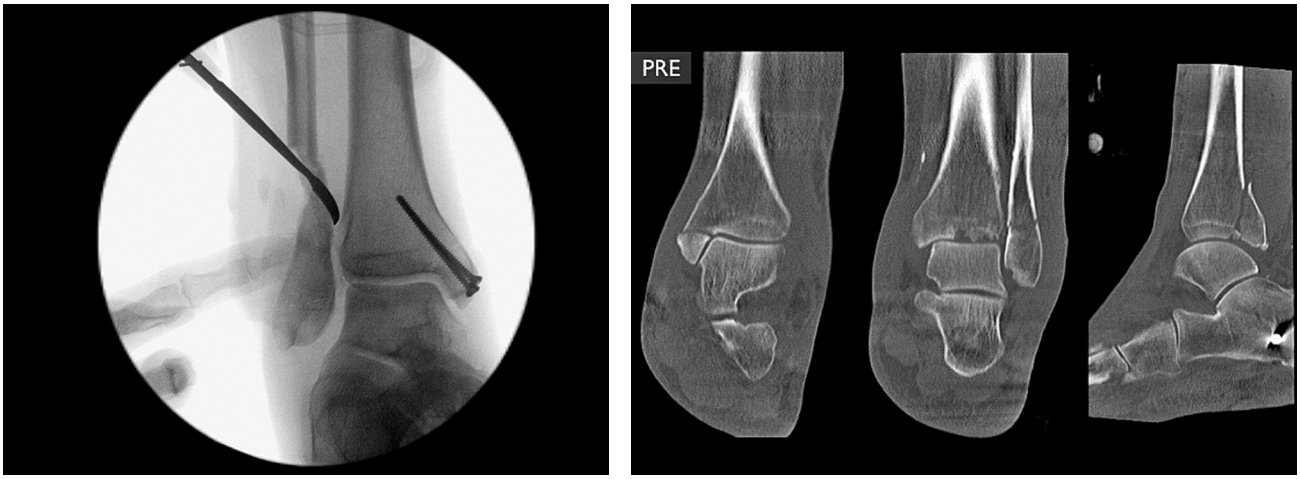


Fig. 7. Malleolar fractures Left: Tri-malleolar fracture with complex Volkmann fragment and interposed small fragment, which makes the reduction difficult and justifies many attempts to obtain an anatomical reduction with repeated use of the C-arm but excluding the surgeon's fingers (cf. details of the case ICUC ID 4).

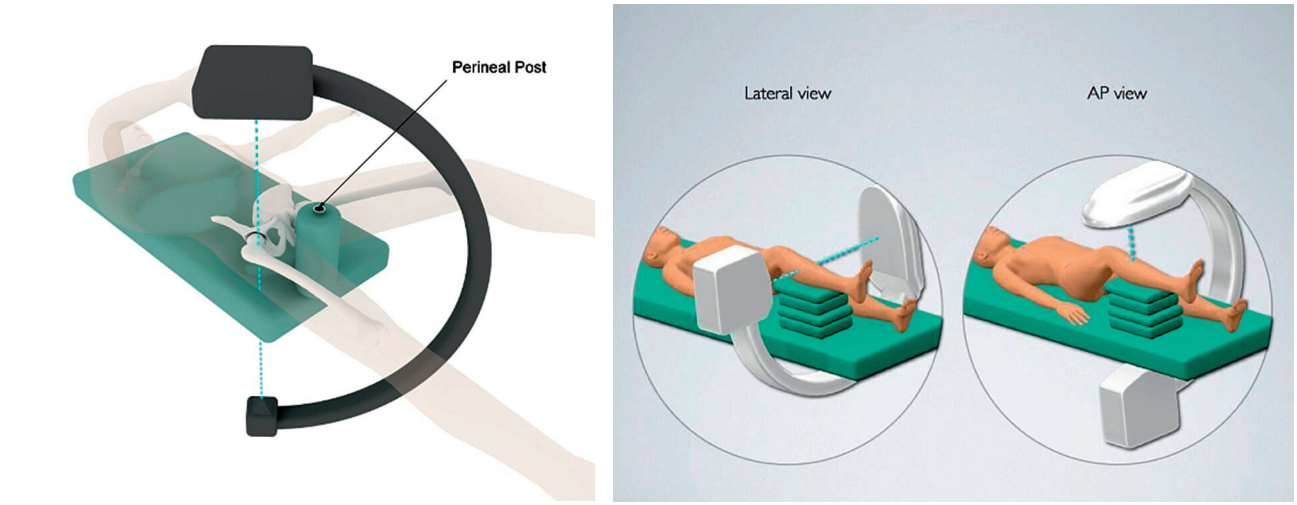


Fig. 8. Diagram of correct position of C-arm. The position of the imaging modality is part of the planning and must be correctly communicated to the OR personnel preoperatively in order not to lose time and to correctly position radiation source and receiver.

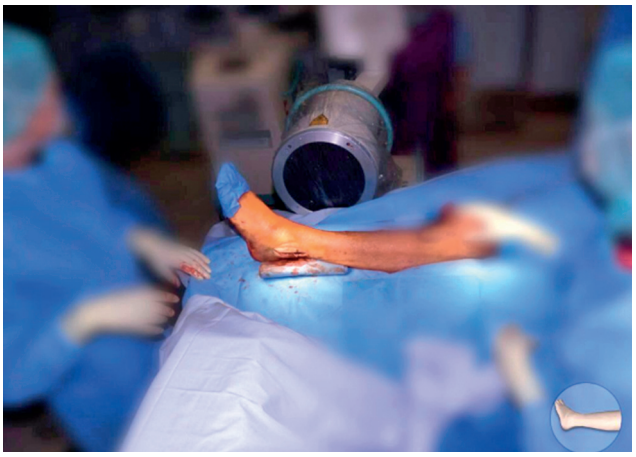


Fig. 9. Position of OR crew ICUC ID:44-TS-673/image 33 of 241 The relative position of the operating crew to the C-arm is crucial for the radiation dose absorbed. Keeping to the minimum distance of 2 m is a question of discipline.

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