Acta Chir. orthop. Traum. čech., 83, 2016, No. 1
p. 9–15

Balancing Success and Risk in Orthopedic Trauma Surgery: The Ridge-Walking between Sound Accepting "Good" and Risky Striving for "Better"

Vyvažování úspěchu a rizik v ortopedické úrazové chirurgii: pohyb "na hraně" mezi hodnocením "dobrý" a riskantní snahou o "lepší"

P. REGAZZONI[1], A. FERNANDEZ[2], S. M. PERREN[3]

[1] Davesco-Soragno/TI, Switzerland
[2] Hospital Britanico, Montevideo, Uruguay
[3] AO Foundation, Davos, Switzerland

SUMMARY

Immediate post-operative rating of surgical performance can be a valuable source of learning when trying to analyze the reasons for the difference between "work as planned" and "work as done".

There are many reasons for the difference, but they can only be found if complete documentation of the surgical steps allows retrospective scrutiny. Documentation like ICUC[1] provides this opportunity for scrutiny and may allow better understanding of some unexpected post-operative evolutions.

[1] www.icuc.net

INTRODUCTION

Manuals, textbooks, guidelines, electronic learning tools and scientific publications describe the options available to treat a given trauma situation. Advice and tricks are offered, hopefully, on how to realize optimal results after careful planning. The literature about how things should be done is extensive (13, 14, 16, 18). The goal is to have a perfect match between the preoperative plan and the postoperative outcome (6). However, there is often a difference between work as planned and work as done (12). Computer-assisted tools help to implement preoperative plans (5, 17). However, the majority of all surgical procedures are still done conventionally. There are a variety of reasons for the afore-mentioned differences, like suboptimal planning, special patient situations, unforeseeable events during the operation, suboptimal technical equipment, and lack of experience of the surgical team, but systematic analyses are missing.

It is very instructive to search for the reasons for the differences between plan and performance. Suboptimal surgical technique can be a cause of such differences. Available ratings of surgical performance are usually based on complication and death rates and functional outcomes (20). These data are important as they are an overall result of the quality of the indication, surgical act and post-operative care. Adjustments based on the general patient status increase the relevance of the results. It is however difficult to find literature about an "immediate postoperative rating of the surgical act", thus excluding an essential factor, the technical performance. Except for trainees, the quality of the surgical act alone is seldom rated. Furthermore, the rating requires complete documentation, allowing objective retrospective analysis (4).

PROBLEM

In certain situations in surgery a decision must be taken intraoperatively on whether the result obtained is acceptable or not. The risks and advantages of an attempt to improve the reconstruction must be weighed up on the spot.

Post-operatively, it would be important to know the acceptability of a deviation from the planned optimum, which is generally as close as possible to normal anatomy (8). Unfortunately, clear and precise data about such tolerances are not often available and the idea of collecting this data is not universally accepted (2, 3, 11). The situation is complicated further by the fact that it is often impossible to predict the consequences of a

deviation from the desired intraoperative result, i.e. its consequences and relevance for the patient.

Usually cases are analyzed at the end of the course and it is easy to find reasons to explain the unexpected outcome. The ex-post analysis of a false prediction might be a useful learning source. Concepts with insufficient evidence for prediction have to be questioned. When sequelae only occur after ten or more years, for example, deviations from perfect results are perhaps more easily accepted, especially in elderly patients. Only a minority of outcome studies show data for individual patients and none of them offer the possibility of tracing back to the individual surgical steps. This is however offered by the complete, detailed and continuous recording of ICUC® (9, 19) by specially trained documentalists who are surgeons certified in Surgicorder® technology.

RESULTS

Table 1 shows an overview of the workflow in fracture treatment with the required decisions and their effects. For the surgeon treating a defined patient an important issue is to know when to accept a technical and functional result and when to take the risk of trying to improve it.

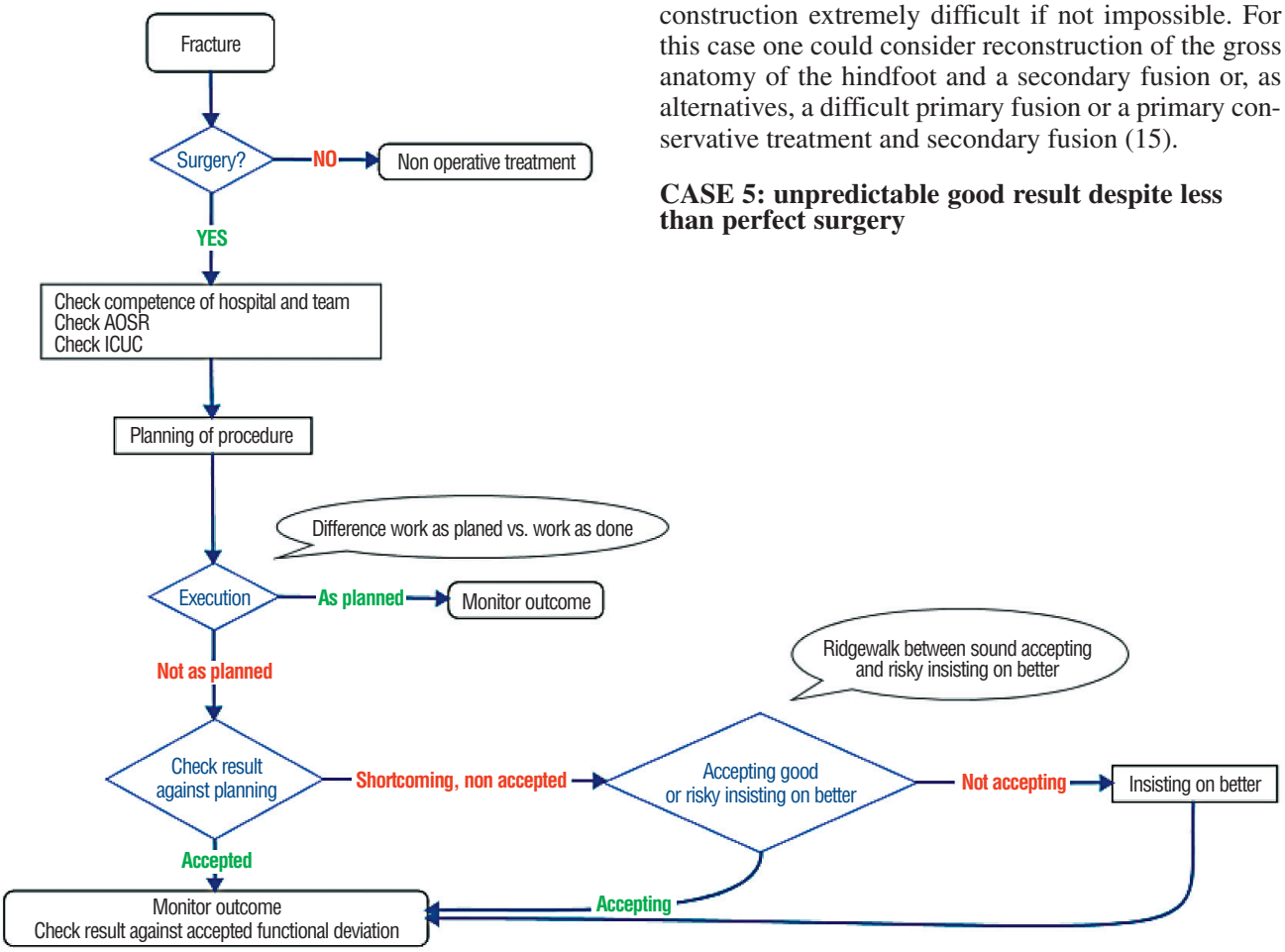

Table 1. Flowchart elucidating the consecutive processes of decision making and the resulting situation. Walking the ridge between sound accepting good and risky insisting at better illustrates Voltaire's statement "better is the enemy of good".

The following examples (cases) illustrate the relationship between immediate post-operative result and function and its predictability.

CASE 1: predictable good function after surgery without shortcomings

Volar approach, a congruent radio-ulnar joint is easily realized using a special clamp, despite literature statements that fractures with displaced dorso-ulnar fragments are particularly challenging when a volar approach is used (1).

Full functional pain free recovery (Fig. 1b) illustrating that reconstruction with only 0° palmar tilt is within tolerance.

CASE 2: predictable limited function after surgery with shortcomings

The distal radio-ulnar joint (DRUJ) and the distal ulna were not reconstructed. The functional loss (Fig. 2b) is predictable from the immediate postoperative X-ray. A second surgery was necessary because of a poorly placed screw protruding into the joint.

CASES 3 and 4: problems predictable with high probability in multi-fragmentary fractures

Functional limitations have to be expected for both cases, after any type of treatment. Congruous joint reconstruction extremely difficult if not impossible. For this case one could consider reconstruction of the gross anatomy of the hindfoot and a secondary fusion or, as alternatives, a difficult primary fusion or a primary conservative treatment and secondary fusion (15).

CASE 5: unpredictable good result despite less than perfect surgery

Fig. 1. Case of a distal radius fracture, selected from the ICUC library to exemplify good surgery with a predictably good result

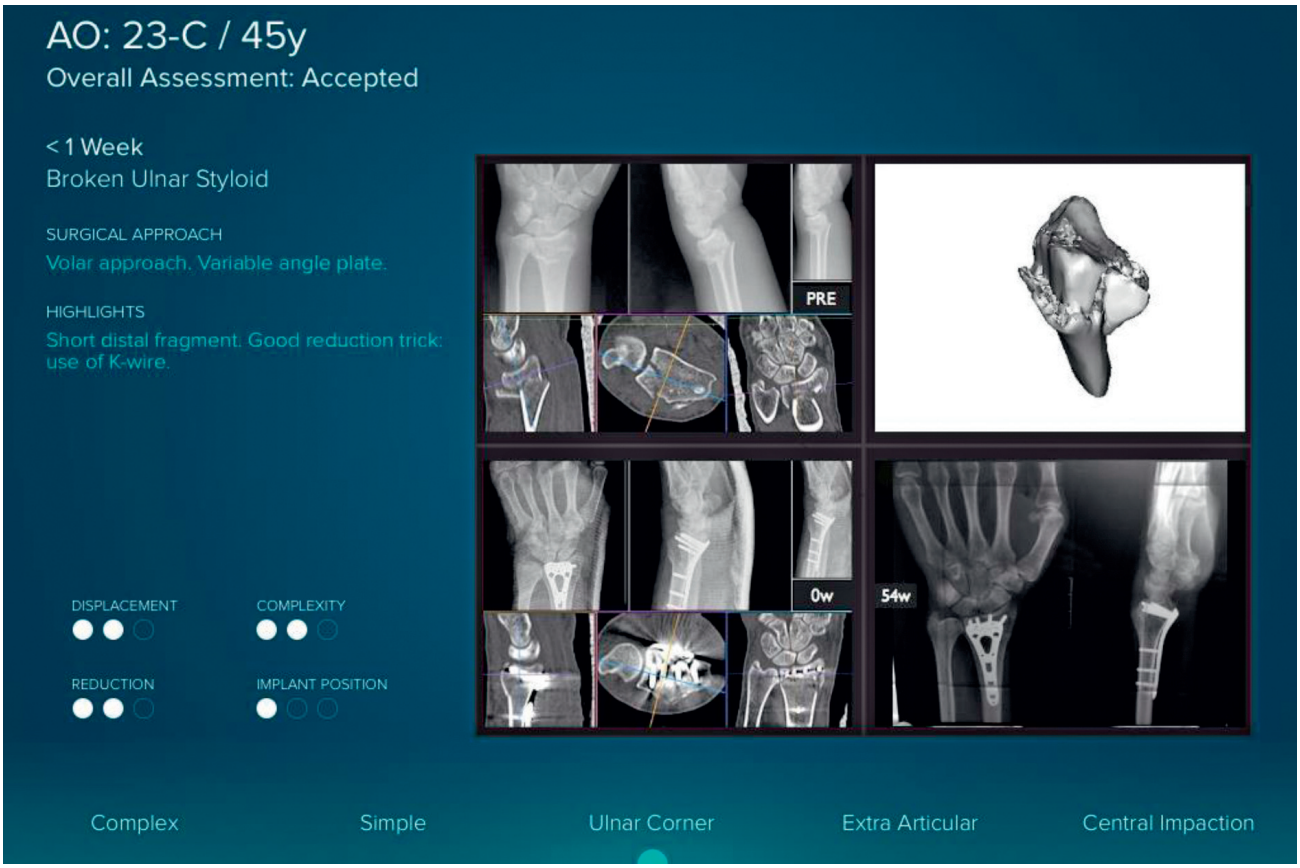

Fig. 1a. Overview of the case (for details see the ICUC app)[i].

DISCUSSION

In a case series it is interesting to see the deviations of every single case from clearly predefined goals (18), as it allows both an understanding of acceptable tolerances and an evaluation of the quality of the surgical act. It is general experience that some cases with shortcomings may go on to produce exceptionally good results. Contrariwise, exaggerated efforts to obtain the planned result may lead to complications, this is *a ridge walk between sound accepting "good" and risky insisting in "better". This is a constant balancing act between sound procedure, accepted as good, and calculated risks to achieve better.*

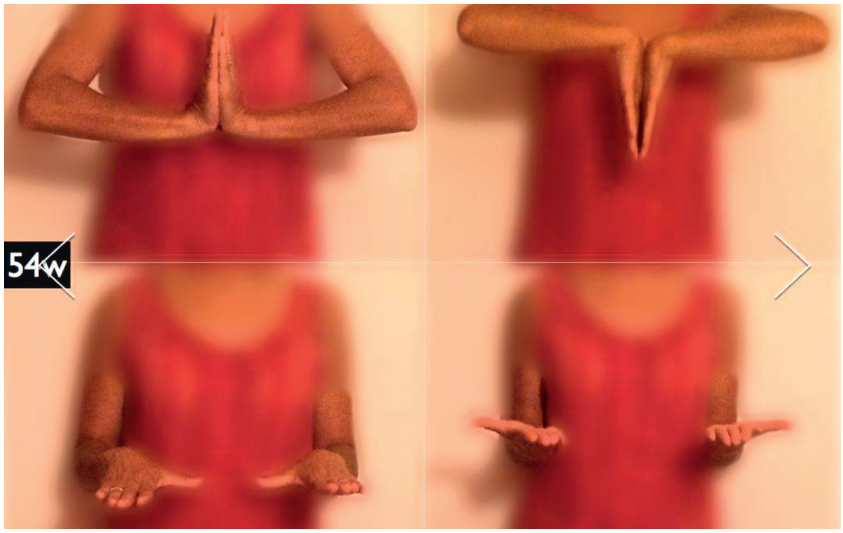

Fig. 1b. Full recovery of function recorded at 54 weeks.

A high quality surgical act is characterized by little difference between work-as-planned and work-as-done if we exclude deviations due to unforeseen events. (12) As stated in the DOE Handbook, Accident and Operational Safety Analysis (12): "The key is that one cannot fix problems one does not see. Seeing the gaps between work-as-done and work as planned provide the required eye-opening moment to recognize a need for change".

[i] ICUC case: upper limb, distal radius, ulnar corner, 23 C / 45 y (pre, CT, 0 w, 54 w)

Complete documentation of the surgical act (Surgicorder®) as offered by the ICUC® app might allow the intra-operative technical errors to be pinpointed by secondary analysis, like a flight recorder in aviation. As transparent information is a fundamental right of patients

Fig. 2. Case of a distal radius fracture, selected from the ICUC library to exemplify?

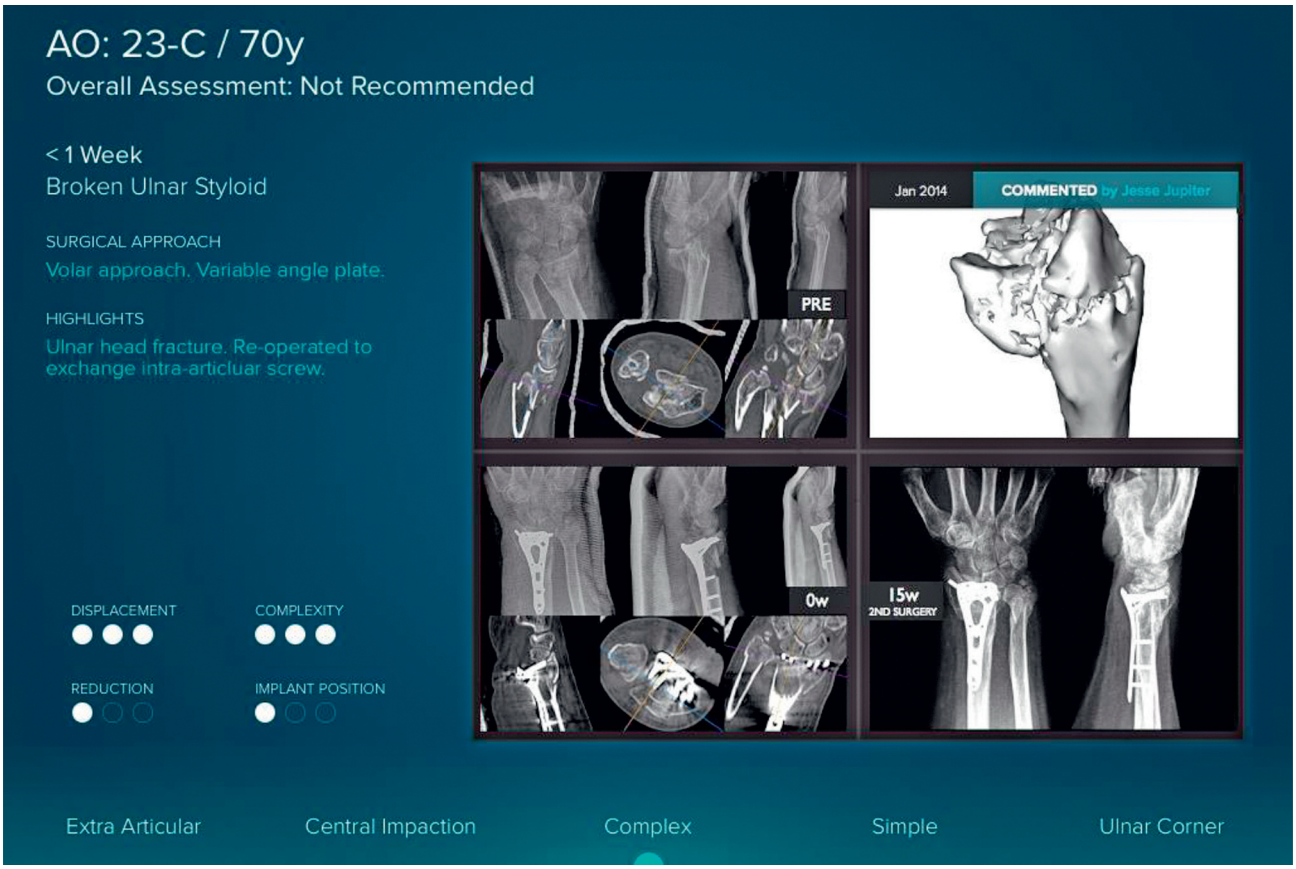

Fig. 2a. Overview of the case (ICUC app)[ii].

Fig. 2b. Function recorded at 15 w: limited flexion but astonishing pro-supination at 15 w, despite suboptimal surgery.

Fig. 3. Multifragmentary fracture of os calcis.

[ii] ICUC case: upper limb, distal radius, complex, 23 C / 70 y (pre, CT, 0 w, 15 w)

the surgeons have to remind them preoperatively that predictions are difficult and that certain pathologies do not allow a "*restitutio ad integrum*" when the trauma is too extensive (cases 3 and 4). Furthermore, it is not realistic to expect surgeons to perform optimally on every occasion (case 5).

Fig. 5. Dorsally displaced distal radius fracture

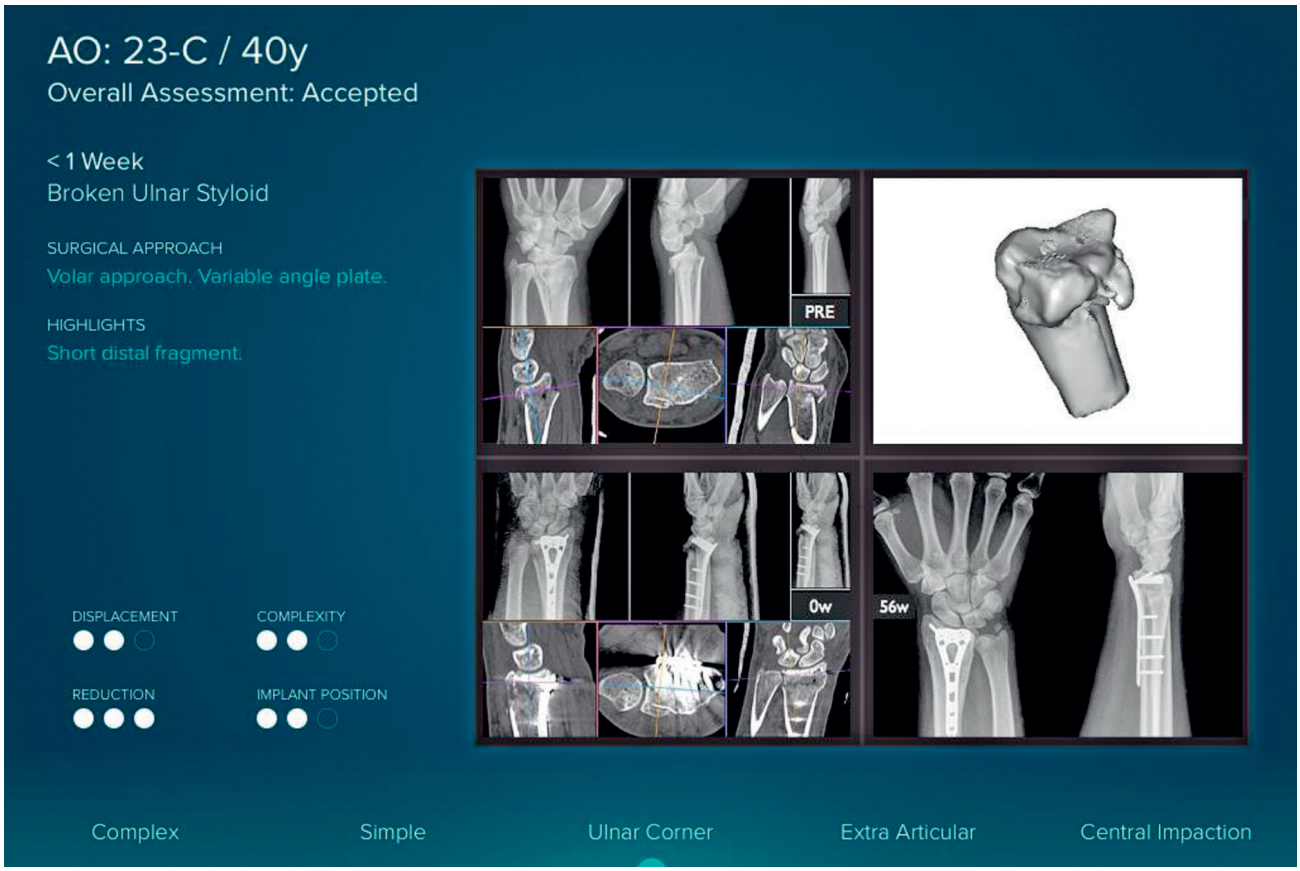

Fig. 5a. Overview of the case (for details cf. ICUC app)[iii]. DRUJ not perfect, but apparently within tolerance.

[iii] ICUC case: upper limb, distal radius, ulnar corner, 23 C / 40 y (pre, CT, 0 w, 56 w)

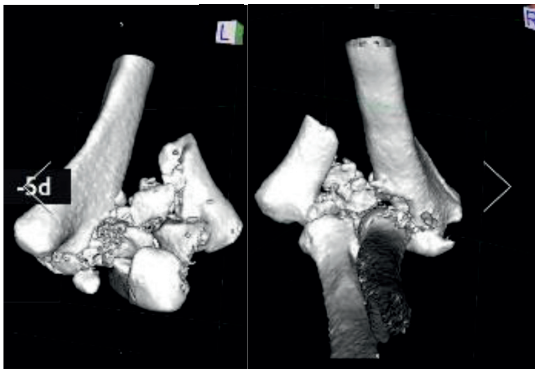

Fig. 4. Multifragmentary fracture of distal humerus. The options are a reconstruction or primary elbow arthroplasty. Short- or long-term problems are unavoidable (7, 10).

Fig. 5b. Function at 56 w. Pro-supination at 56 w is perfect and painless. Will this deteriorate with time, or is slight incongruity acceptable in a non-weight-bearing extremity?

Faced with a given problem surgeons usually plan and try to follow guidelines, textbooks and reference publications (14, 16, 18). Sometimes implementation does not conform. The consequence of such a deviation can be a complication, e.g. implant fatigue failure or an unexpectedly acceptable result. Based on previous experiences with implant fatigue after treatment with single plates a complex femur shaft fracture with

Fig. 6. Complex, segmental comminution fracture of the distal femur, selected from the ICUC app as an example

Fig. 6a: Overview of the case[iiii]. Treatment with primary double plating. Consolidation slow, but no fatigue failure of implants, despite early full weight bearing. We propose the term "fatigue resistant internal fixation" for such constructs (13).

[iiii] ICUC case: lower limb, femur shaft, complex, 32 C3 /50 y (pre, 0 w, 28 w, 98 w)

segmental comminution (shown in Figs 6a and 6b) was treated with a primary double plating. At 0 and 28 weeks the fracture is far from consolidated, knee function is limited in both flexion and extension but the patient has no pain and is putting full weight on the leg. In such a situation the majority of surgeons would suggest further surgical actions (bone graft or growth factors), but – in contrast to cases treated with a single lateral plate – no fatigue occurred in case 6 and the fracture did consolidate without any further surgery. Does such a construct illustrate a "fatigue resistant internal fixation"? (13).

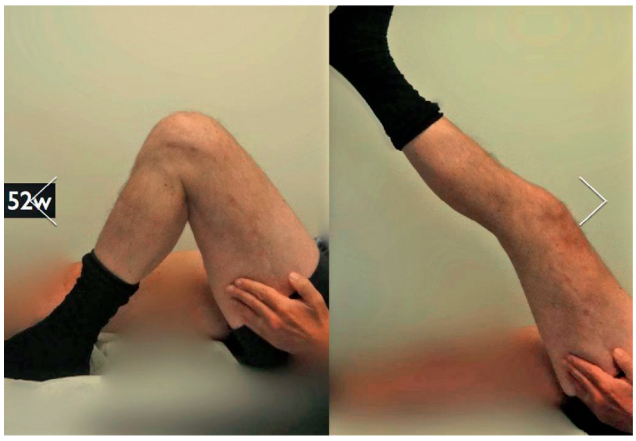

Fig. 6b. Function at 52 weeks. Pain free limited function, but no effect on functions of daily life.

CASE 6: Unpredicted course after "non-canonical" construct

Experience tells us that, in other cases not illustrated here, despite good surgery according to guidelines, we do sometimes see *unpredictable limited function* or an inexplicable pain. Many different reasons have then to be considered, sometimes without conclusion: among others

– wrong after-treatment with long immobilization and fibrosis,
– reflex dystrophy,
– peripheral nerve pathologies,
– pathologies not objectified primarily and possibly evident only during the later course,
– expectations from worker's compensations insurance,
– simulation,
– etc.

CONCLUSIONS

Suboptimal surgical performance can be one of the reasons for a difference between planning and performance. The analysis of the difference is a valuable source for learning. Its prerequisite is complete documentation of the surgical act allowing retrospective analysis and recognition of deviations from the defined goals and acceptable tolerances. Intra- or post-operatively the surgeon can be faced with the dilemma of sound acceptance of a given suboptimal result or risky insistence on striving for better. Unpredicted evolutions might help towards a better understanding of certain biomechanical phenomena. Complete documentation of the surgical steps as offered by ICUC® is helpful.

References

1. DY, C. J., WOLFE, S. W., JUPITER, J. B., BLAZAR, P. E., RUCH, D. S., HANEL, D. P.: Distal radius fractures: strategic alternatives to volar plate fixation. Instr. Course Lect., 63: 27–37, 2014.
2. GUGENHEIM, J. J., PROBE, R. A., BRINKER, M. R.: The effects of femoral shaft malrotation on lower extremity anatomy. J. Orthop. Trauma. 18: 658–664, 2004.
3. HEFTI, F.: Pediatric orthopedics in practice. Second edition, Berlin, Springer 2015.
4. LARSON, J. L., WILLIAMS, R. G., KETCHUM, J., BOEHLER, M. L., DUNNINGTON, G. L.: Feasibility, reliability and validity of an operative performance rating system for evaluating surgery residents. Surgery,. Oct;138(4):640–649, 2005.
5. LEIGGENER, C., MESSO, E., THOR, A., ZEILHOFER, H. F., HIRSCH, J. M.: A selective laser sintering guide for transferring a virtual plan to real time surgery in composite mandibular reconstruction with free fibula osseous flaps. Int. J. Oral Maxillofac. Surg., 38: 187–192, 2009.
6. LÜTZNER, J., KRUMMENAUER, F., WOLF, C., GÜNTHER, K. P., KIRSCHNER, S.: Computer-assisted and conventional total knee replacement: a comparative, prospective, randomised study with radiological and CT evaluation. J. Bone Jt Surg., 90-B: 1039–1044, 2008.
7. MCKEE, M. D., VEILLETTE, C. J., HALL, J. A., SCHEMITSCH, E. H., WILD, L. M., MCCORMACK, R., PEREY, B., GOETZ, T., ZOMAR, M., MOON, K., MANDEL, S., PETIT, S., GUY, P., LEUNG, I.: A multicenter, prospective, randomized, controlled trial of open reduction--internal fixation versus total elbow arthroplasty for displaced intra-articular distal humeral fractures in elderly patients. J. Shoulder Elbow Surg., 18: 3–12, 2009.
8. MINIACI-COXHEAD, S. L., MARTIN, E. A., KETZ, J. P.: Quality and utility of immediate formal postoperative radiographs in ankle fractures. Foot Ankle Int., 36: 1196–1201, 2015.
9. MÜLLER, A.: Ein Konzept für ein fallbasiertes Teaching in der Unfallchirurgie. Inauguraldissertation, Universität Basel, 2004.
10. MÜLLER, L. P., KAMINENI, S., ROMMENS, P. M., MORREY, B. F.: Primary total elbow replacement for fractures of the distal humerus. Oper. Orthop. Traumatol., 17: 119–142, 2005.
11. PALEY, D.: Principles of deformity correction. Springer 2014.
12. PEGRAM, D., DEBUSK, R.: DOE Handbook: Accident and operational safety analysis. Vol II, Washington D.C., US Department of Energy 2012.
13. PERREN, S. M., REGAZZONI, P., FERNANDEZ, A.: Biomechanical and biological aspects of defect treatment in fractures using helical plates. Acta Chir. Orthop. Traum. čech., 81: 267–271, 2014.
14. ROCKWOOD, C., BUCHOLZ, R., COURT-BROWN, C., HECKMAN, J., TORNETTA, P.: Rockwood and Green's fractures in adults. Philadelphia, Lippincott Williams & Wilkins 2010.
15. RUBINO, R., VALDERRABANO, V., SUTTER, P. M., REGAZZONI, P.: Prognostic value of four classifications of calcaneal fractures. Foot Ankle Int., 30: 229–238, 2009.
16. RÜEDI, T., BUCKLEY, R., MORAN, C.: AO principles of fracture management. Davos, AO Publishing 2007.
17. VARGA, E. Jr.: Computerized treatment planning and its realization in maxillofacial surgery and in dental implantology. Ph.D. Thesis, Faculty of Medicine, University of Szeged, Szeged 2014.
18. www.aosurgery.org (AO Surgery Reference)[2]
19. www.icuc.net
20. www.projects.propublica.org

Corresponding author:
Prof. Stephan M. Perren, founding member and scientific advisor
AO Foundation
Dischmastr. 22
CH-7260 Davos, Switzerland
E-mail: sperren@bluewin.ch