Delayed Healing / Non-healing after IM nailing

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Introduction: A non-union after intra-medullary nailing requires careful consideration of the different possibilities of treatment. In the following we discuss the pros and cons when more than one valuable solution exists *(1)*. For this purpose, we use cases from the ICUC database as well as some anecdotal cases. The literature proposes exchange-nailing, plate augmentation *(2)* and dynamization as treatment options for delayed or non-healing after intra-medullary nailing (Fig. 1-5) *(3–6)*. An essential argument in such a consideration is surgical invasiveness *(7)*.

Discussion of the literature: There is good evidence for intramedullary nails as preferred treatment for the majority of femoral shaft fractures. Healing complications, however, are not rare *(8, 9)*. Nonunion is significantly correlated with distal fracture, unsatisfactory reduction and the use of unreamed nails. Treatment tactic for these cases remains controversial. Exchange nailing with or without bone grafting, compression plating, plate augmentation, with or without cerclage and grafting and the so-called dynamization are proposed, both for femur and tibia *(9, 10)*. Some of these treatments are quite invasive. Dynamization is technically simple and not expensive but only promising for special cases, and biomechanically hard to understand, since removal of locking screws not only allows axial sliding over the nail, but generates at the same time rotational instability. The following clinical examples show alternatives.

Documents, especially intra-operative images, of surgical cases are often scarce. A complete intraoperative image documentation allows a deepened secondary analysis and is a valuable source of learning *(7, 11)*.

Fig. 1: **Hypertrophic non-union after femur nailing**: healing after "reamed exchange-nailing", considered the standard solution for a short oblique fracture at the isthmus. An alternative. Is shown in Fig. 2-5. It is difficult to decide which procedure is less invasive, considering that usually exchange nailing includes reaming, considered to be advantageous for healing. Medullary reaming, however, has been shown to have considerable general effects *(12)*. Using special techniques, reamer debris are not wasted and their osteo-inductive elements (stem cells and growth factors), wasted during exchange nailing, enhance healing *(13)*.

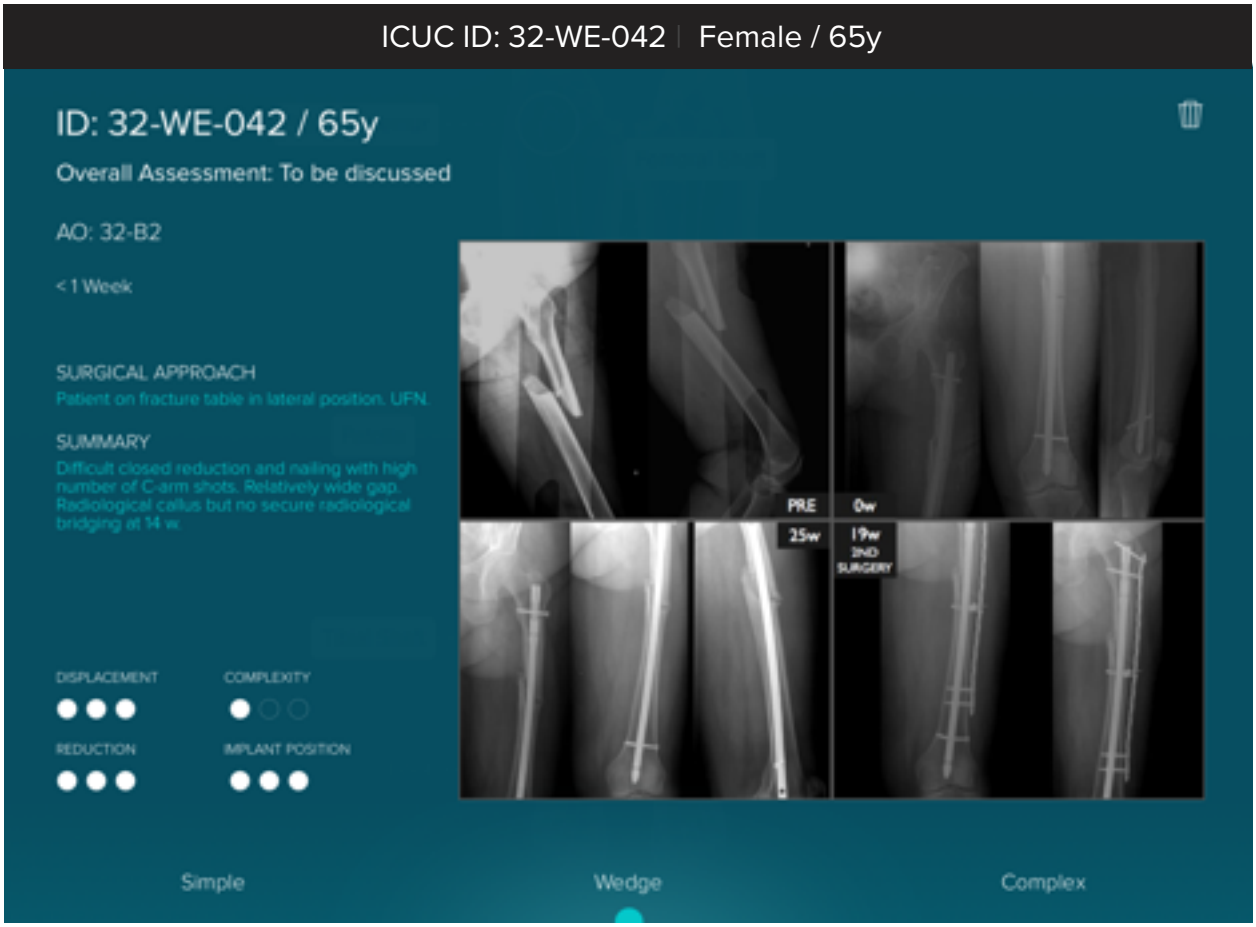

***Fig. 2:* Delayed Healing of a wedge fracture of the femur shaft after nailing, 65y old patient.** 25 weeks after nailing, despite some callus formation pain persisted and the fracture was not consolidated (cf. Fig. 3). Healing after application of an additional internal fixator and a cerclage. *ICUC® App Case ID: 32-WE-042.*

***Fig. 3:* Evolution of femur fracture of Fig. 2.** X-ray at 29 weeks shows a breakage of the distal locking screw as symptom of persisting instability and cyclic load on the screw. *ICUC® App Case ID: 32-WE-042, image 57 of 288).*

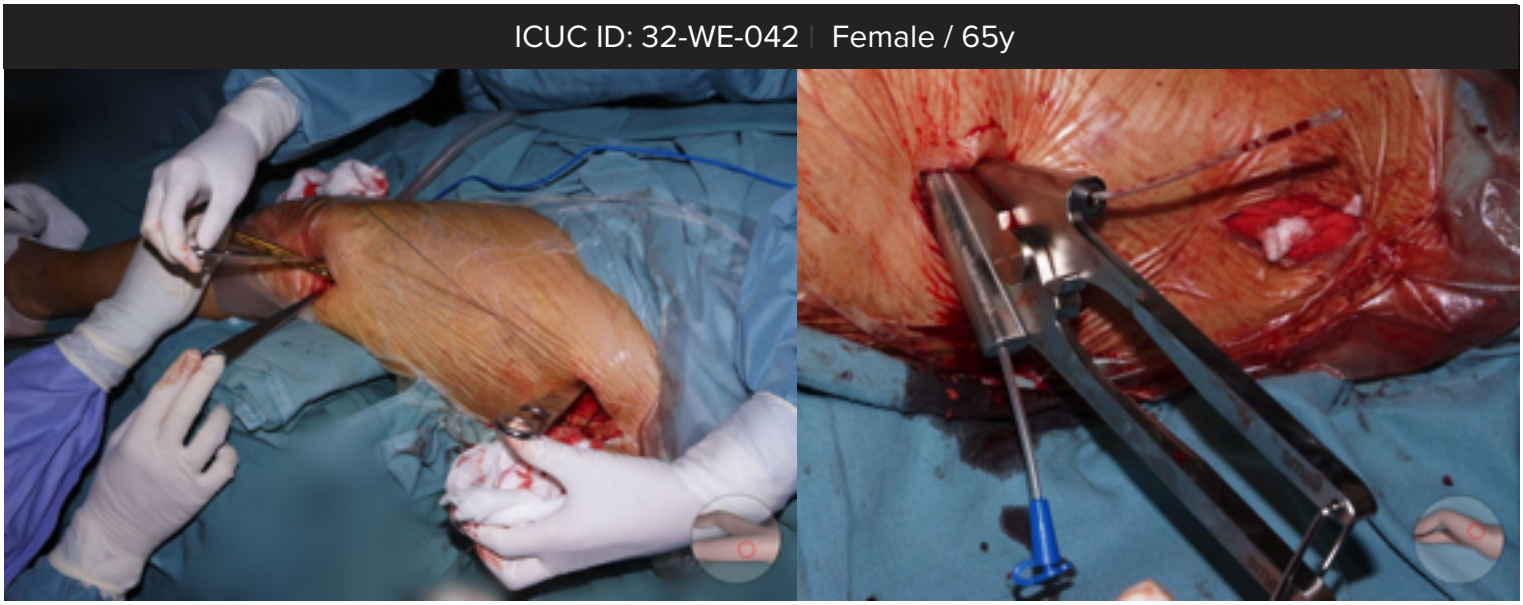

Fig. 4: **Second surgery of femur fracture of** Fig. 2 and 3: A bridge plate (left image) was slid onto the bone through two small incisions and a MIO cerclage (right image) was added and the nail left in place. Uneventful healing and good function followed. (cf. Fig. 5). *ICUC® App Case ID: 32-WE-042, image 78 and 148 of 288.*

Fig. 5: **result after second surgery of femur fracture of Fig. 2-4.** Uneventful healing after addition of a plate and a cerclage by minimally invasive technique. *ICUC® App Case ID: 32-WE-042, image 172 and 173 of 288.*

The technique shown in Fig. 2-5 is technically simple. Plate augmentation is an alternative to reamed exchange nailing *(3–5)* for a short oblique fracture at the isthmus.

Fig. 6: **Plate-nail combination to correct a technically unsatisfactory nailing in this case in a infra-isthmus short oblique fracture where exchange nailing is not an option**. Plate augmentation was used after this technically insufficient nailing: removal of distal locking screws, correction of reduction leaving the old nail and adding a plate led to uneventful consolidation. This old case illustrates an alternative to more complex and invasive techniques.

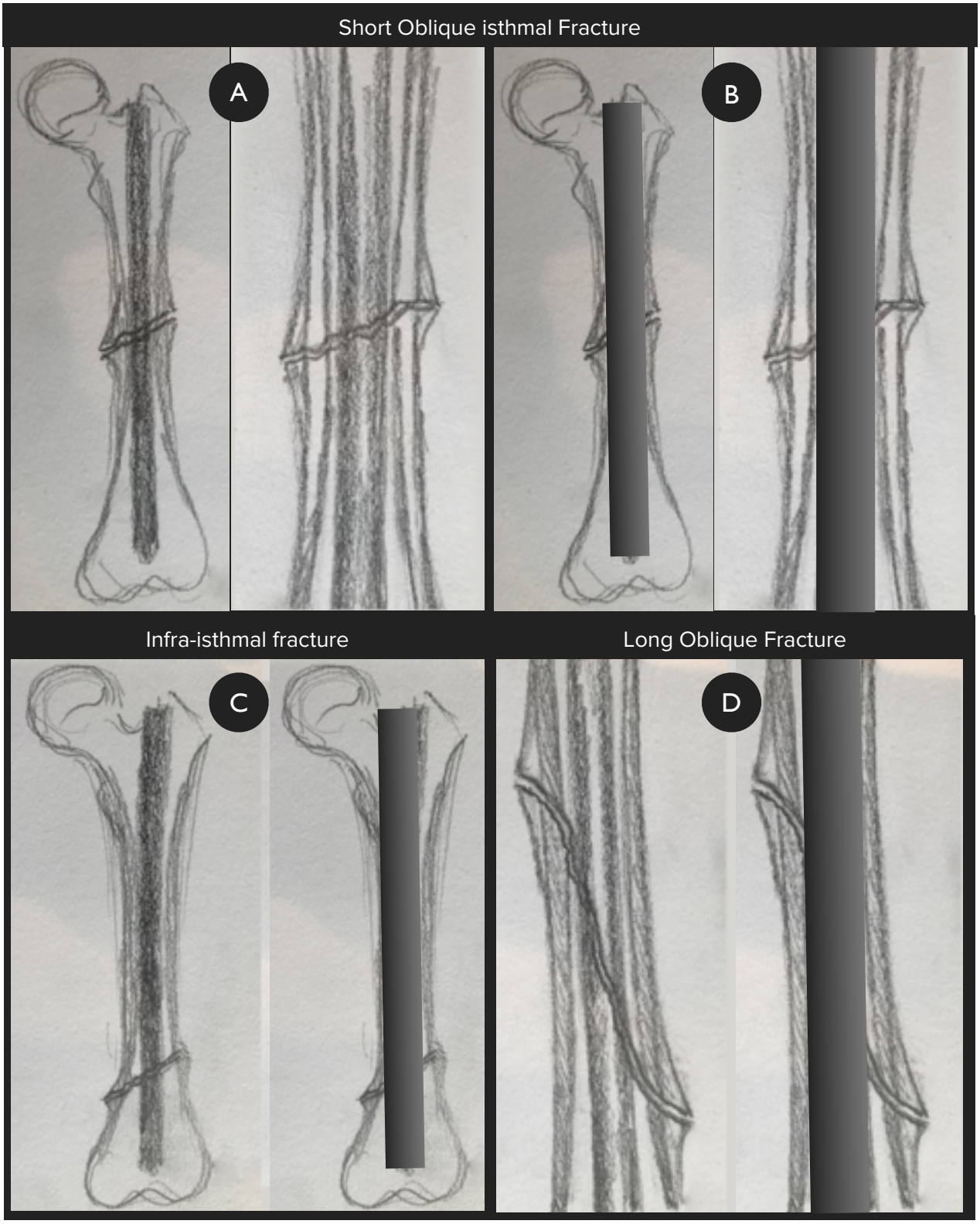

Fig. 7: **Exchange nailing should only be a valid option in short oblique fractures at the isthmus (A).** A thicker nail improves the contact with both main fragments, achieving a higher construct stiffness (B). This is not true for all other fracture types and locations, where plate augmentation is a better option (C and D).

Summary: Nailing is the preferred treatment of femur shaft fractures. For delayed unions or non-unions “reamed exchange nailing” and plate augmentation, used as tools to increase construct stiffness, seem to be the treatment of choice. Dynamization should not be considered anymore. In view of the general effects of medullary reaming, possibly less invasive alternatives might be interesting. Simply adding an internal fixator – by minimally invasive techniques - leaving the nail in place could be such a technically simple alternative.

Literature Cited

1. Regazzoni P, Pace A, Fernández Dell'Oca AA, Perren SM. From Diagnosis to Therapy Planning. ICUC Newsletter 2017; (18):1–9. Available from: URL: www.icuc.net.

2. Chiang JC, Johnson JE, Tarkin IS, Siska PA, Farrell DJ, Mormino MA. Plate augmentation for femoral nonunion: More than just a salvage tool? Arch Orthop Trauma Surg 2016; 136(2):149–56.

3. Banaszkiewicz PA, Sabboubeh A, McLeod I, Maffulli N. Femoral exchange nailing for aseptic non-union: not the end to all problems. Injury 2003; 34(5):349–56.

4. Hak DJ, Lee SS, Goulet JA. Success of exchange reamed intramedullary nailing for femoral shaft nonunion or delayed union. J Orthop Trauma 2000; 14(3):178–82.

5. Hierholzer C, Glowalla C, Herrler M, Rüden C von, Hungerer S, Bühren V et al. Reamed intramedullary exchange nailing: Treatment of choice of aseptic femoral shaft nonunion. J Orthop Surg Res 2014; 9:88.

6. Pihlajamäki HK, Salminen ST, Böstman OM. The treatment of nonunions following intramedullary nailing of femoral shaft fractures. J Orthop Trauma 2002; 16(6):394–402.

7. Regazzoni P, Fernández Dell'Oca AA, Perren SM. Considering surgical invasiveness. ICUC Newsletter 2016; (8):1–4. Available from: URL: www.icuc.net.

8. Drosos GI, Bishay M, Karnezis IA, Alegakis AK. Factors affecting fracture healing after intramedullary nailing of the tibial diaphysis for closed and grade I open fractures. J Bone Joint Surg Br 2006; 88(2):227–31.

9. Litrenta J, Tornetta P, Vallier H, Firoozabadi R, Leighton R, Egol K et al. Dynamizations and Exchanges: Success Rates and Indications. J Orthop Trauma 2015; 29(12):569–73.

10. Vaughn J, Gotha H, Cohen E, Fantry AJ, Feller RJ, van Meter J et al. Nail Dynamization for Delayed Union and Nonunion in Femur and Tibia Fractures. Orthopedics 2016; 39(6):e1117-e1123.

11. Regazzoni P, Giannoudis PV, Lambert S, Fernandez A, Perren SM. The ICUC(R) app: Can it pave the way for quality control and transparency in medicine? Injury 2017; 48(6):1101–3.

12. Pape H-C, Giannoudis P. The biological and physiological effects of intramedullary reaming. J Bone Joint Surg Br 2007; 89(11):1421–6.

13. Masquelet A-C, Benko PE, Mathevon H, Hannouche D, Obert L. Harvest of cortico-cancellous intramedullary femoral bone graft using the Reamer-Irrigator-Aspirator (RIA). Orthop Traumatol Surg Res 2012; 98(2):227–32.