

# CASE REPORT

## From Malunion to Precision: 3D-Planned Metacarpal Correction With Patient Specific Plate

### The Surgeon

#### **Dr. med. Dominique Nellie Merky**

Dr. Merky is currently the Deputy Head of Hand and Peripheral Nerve Surgery at the Inselspital, University Hospital in Bern, Switzerland. It is the largest Level A center for hand trauma and replantation referral center in Switzerland. The full spectrum of hand surgery and peripheral nerve surgery is performed there. She serves as a lecturer and instructor in numerous national and international courses on hand, wrist, nerve, and forearm surgery for multiple surgical specialties.

### Introduction

There are many well-established techniques for corrective osteotomies of the hand, using K-wires, plates, screws, and other standard fixation methods. However, when the deformity becomes more pronounced, multiplanar, or intra-articular, more advanced techniques are often required. Over the past several years, 3D planning based on CT imaging and patient-specific cutting guides have been increasingly adopted for such cases.[1] These methods allow more accurate correction of complex deformities [2] and also make intra-articular osteotomies technically feasible. In addition, they can significantly reduce operative time.[1] Multiple osteotomies can also be planned preoperatively, which is certainly possible freehand but can be challenging in the small bones of the hand.

Traditionally, 3D planning and guide systems have been used together with standard plates or screws. However, this approach has limitations, particularly in complex reconstructions: conventional plates may not conform perfectly to the post-correction anatomy, leading to torque, malposition, or step-off, and prominent hardware may place soft-tissue structures (such as tendons and nerves) at risk.

For these situations, patient-specific fixation plates are indicated. These have recently become available for use in the hand skeleton, offering a tailored fit that improves accuracy, reduces soft-tissue irritation, and enhances the reproducibility of complex corrective procedures.

# The Case



## Patient History / Profile

A 33-year-old healthy male patient sustained a work-related injury when a brick fell onto his right, dominant hand while working as a mason. He was treated conservatively for a fifth metacarpal fracture. This resulted in a symptomatic malunion with shortening, supination, and angular deformity.



## Preoperative Clinical Findings

The patient presented to our clinic two years after the initial injury. On inspection, a pronounced rotational and angular deformity of the little finger was evident, with a functionally relevant flexion malalignment of the metacarpal head. Range of motion at the MCP joint was markedly limited (MCP 55–0–35°). Grip strength was reduced to approximately 50% compared with the contralateral side, and forceful grasping elicited pain radiating into the forearm, consistent with a quadriga effect resulting from shortening of the fifth ray. Additionally, there was focal tenderness over a prominent palmar aspect of the metacarpal head, accompanied by secondary tenosynovitis. Radiographs confirmed the malunion (Figure 1).

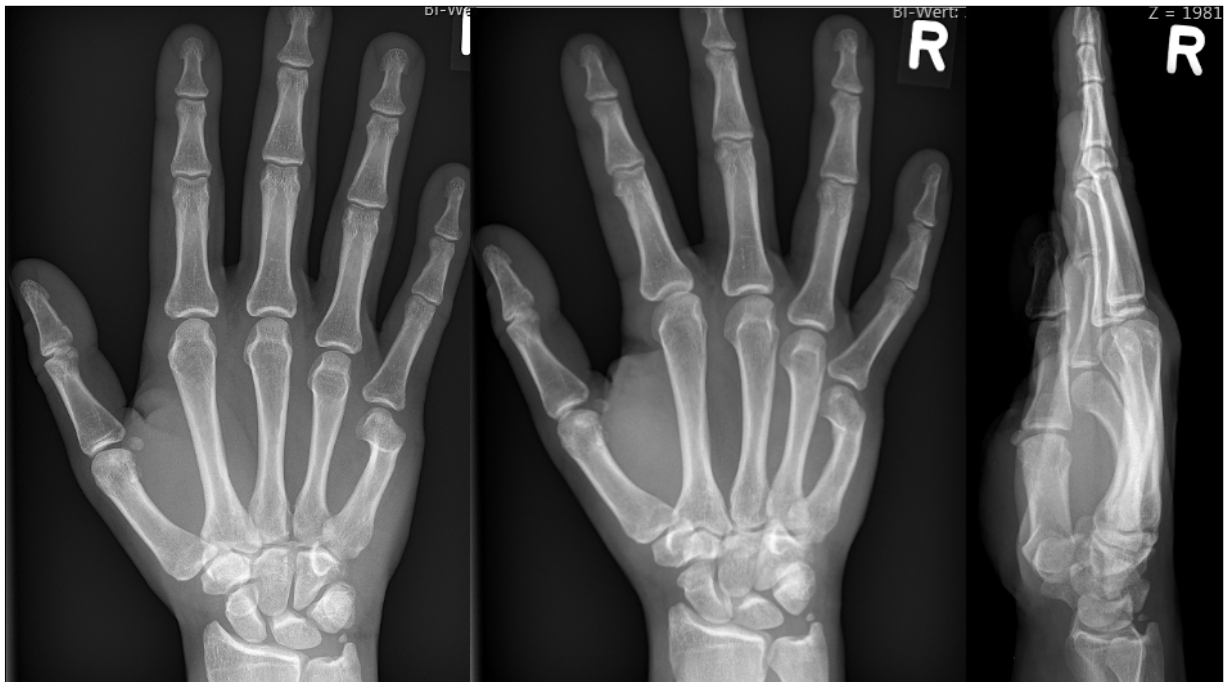


Figure 1:  
Preoperative X-ray

Given the complex and pronounced malunion, we performed a 3D analysis using the contralateral side as a template (Figure 2). We then proceeded with the osteotomy planning. A single osteotomy (Figure 3A) would have required an excessive correction, so a double osteotomy was selected instead (Figure 3B). A conventional plate was deemed unsuitable due to the irregular dorsal surface, the likelihood of hardware prominence, and the mismatch between the screw-hole trajectory and the corrected fragments. Therefore, we elected to use a patient-specific plate (Figure 3C).

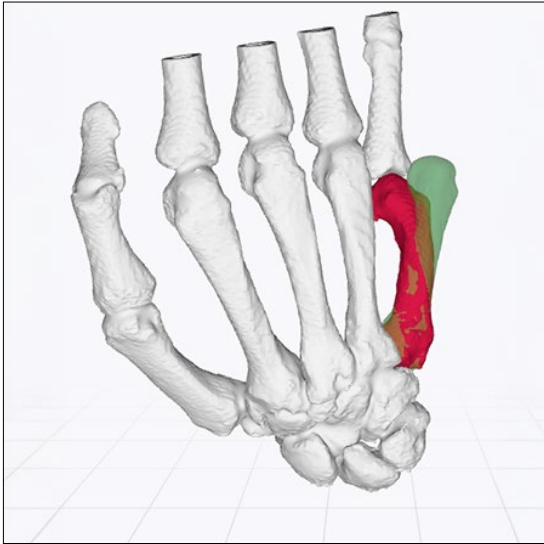


Figure 2:  
3D Analysis using the unaffected contralateral side as a template

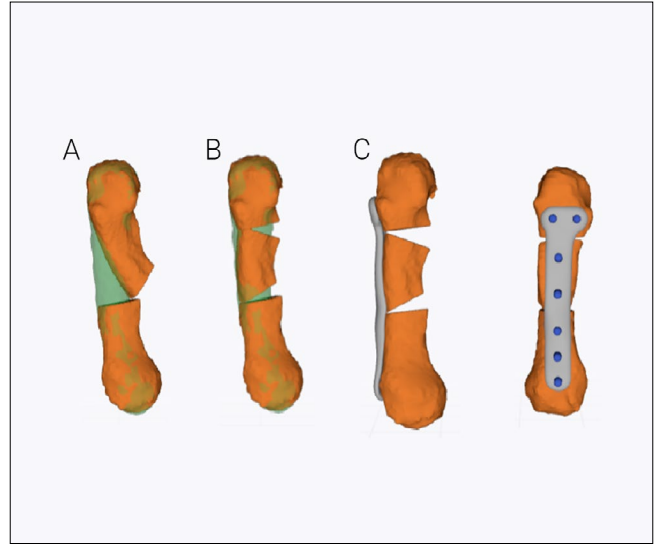


Figure 3:  
3D Planning of the correction. **A** Reconstruction option with a single osteotomy. **B** Reconstruction option with a double osteotomy. **C** Bone rendering with the superimposed custom plate and screw trajectories.

We selected a plate thickness of 1.5 mm with 2.0 mm screws, which is clearly indicated in strong, young patients. And of course, the corresponding patient-specific cutting guide was planned accordingly (Figure 4).



Figure 4:  
Bone model with applied cutting guide (left) and the custom plate (right)



### Surgical Treatment

We used the standard dorsal approach to the fifth metacarpal, fully exposing (Figure 5A) and denuding the bone dorsally to ensure an optimal fit of the patient-specific guide. Once the cutting guide was correctly seated on the bone, it was secured with K- wires (Figure 5B). The future screw holes for the 2.0 mm screws were then pre-drilled through the guide. Only after that were the two osteotomies performed, and the guide was subsequently removed (Figure 5C). Finally, the patient-specific plate was positioned and fixed using the pre-drilled screw holes (Figure 5D, 6).

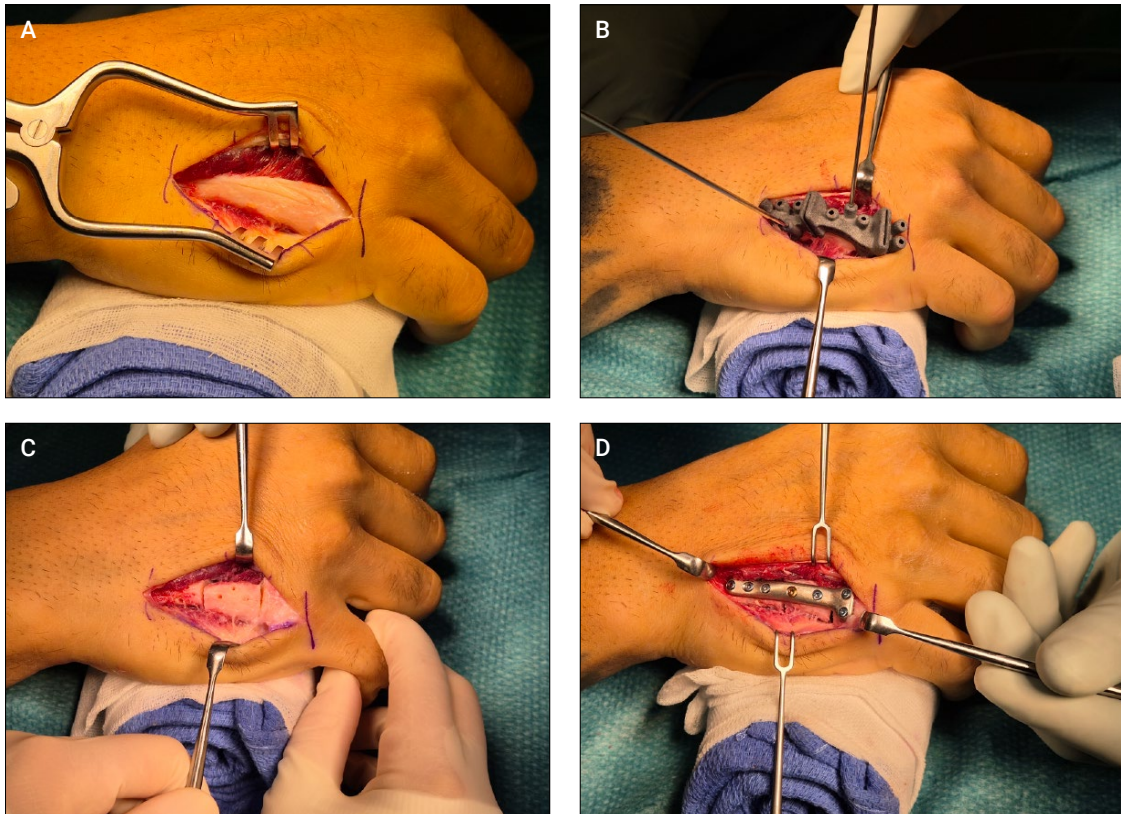


Figure 5:  
 Intraoperative steps: **A** Exposing the bone surface, **B** Application and temporary fixation of the cutting guide, **C** View after removal of the drill and cutting guide, **D** Positioning of the plate



Figure 6:  
 Fluoroscope image showing the plate in situ



### Postoperative Treatment

Initially, the patient was immobilized in an intrinsic-plus splint for four days. This was then changed to a metacarpal brace, and non-weight-bearing mobilization of all fingers and the wrist was initiated. Protected motion was maintained until the clinical and radiographic follow-up at six weeks (Figure 7), after which gradual loading and strengthening were started.

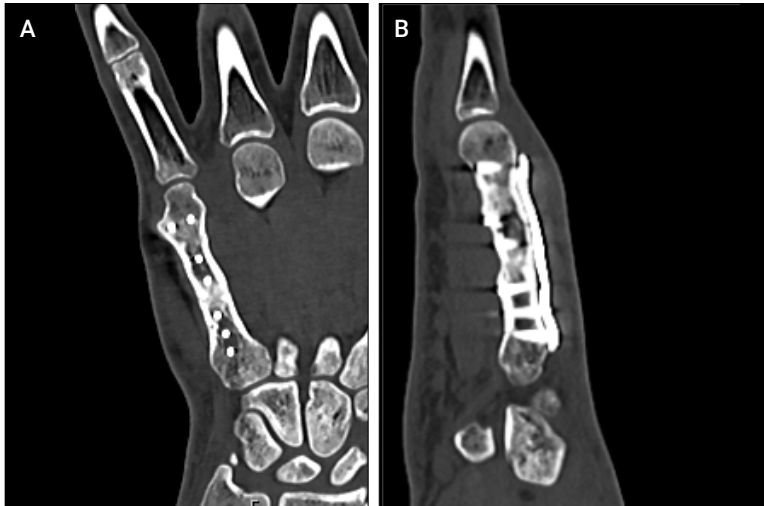


Figure 7:  
CT scan **A** coronal and **B** sagittal view of the metacarpal reconstruction



### Conclusion

The postoperative course was uneventful. This was likely facilitated by the accurate correction achieved and the stability provided by the patient-specific plate, allowing for early functional rehabilitation. Operative time was also reduced due to the straightforward intraoperative workflow enabled by precise preoperative planning. We expect that plate removal will not be necessary, as the implant sits flush and is unlikely to cause soft-tissue irritation. One noteworthy limitation encountered during planning was the variability in finger positioning during CT acquisition. Because the fingers are imaged in a non-physiological posture rotational alignment of the digits cannot be reliably quantified, furthermore ligamentotaxis cannot be assessed. Future improvements in planning protocols or imaging techniques will be required to address this challenge. To mitigate rotational uncertainty, we are currently evaluating patient-specific plates with transverse oblong holes to allow fine-tuning of rotation intraoperatively. Based on our experience, a plate thickness of approximately 1.3 mm is recommended for metacarpal applications to support early mobilization, particularly in patients who may also require concomitant tenolysis or arthrolysis.



### References

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- 2) Roner S, Carrillo F, Vlachopoulos L, Schweizer A, Nagy L, Fuernstahl P. Improving accuracy of opening-wedge osteotomies of distal radius using a patient-specific ramp-guide technique. *BMC Musculoskelet Disord*. 2018;19(1):374. Published 2018 Oct 15. doi:10.1186/s12891-018-2279-0

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