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Failure of double-plate osteosynthesis for the treatment of olecranon fractures in elderly patients

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Fractures of the olecranon are common injuries. They are prone to dislocation due to the force exerted by the triceps muscle. Open reduction and internal fixation are therefore often recommended. The most widely used method is tension band wiring (TBW). It counteracts the tensile forces and puts the fragments under compression. For multifragment fractures, however, some surgeons prefer to use a single dorsal plate. Recently, double-plate osteosynthesis has been proposed as an alternative to the methods mentioned above.[2,7,9,10] The technique consists of stabilizing the bone fragments with 2 low-profile precontoured plates that are placed on the medial and lateral side of the proximal ulna. One of the presumed advantages is that the plates are covered by muscles and not directly under the skin, thus causing less soft tissue irritation and requiring fewer hardware removals than other implants.[5] Manufacturers and users also emphasize that 2 low-profile plates offer more fixation options, allow smaller fragments to be grasped, and provide better rotational stability.[6,10] Surgeons using this technique reported excellent clinical results and a low rate of complications.[2,9] The present report describes 2 cases in which this method failed. Both patients consented to the publication of their medical history and X-rays in a scientific journal.

Case 1

Patient history

A 70-year-old active and healthy right-handed woman tripped and fell on her right elbow. She immediately felt severe pain and could no longer move her arm. She rested and waited for the previously scheduled appointment to assess pain in her left wrist, which she had broken 6 months earlier and that had been treated with open reduction and internal fixation. Radiographs in 2 planes of the right elbow and the left wrist revealed a dislocated olecranon fracture with a depressed articular fragment (Fig. 1, *A*) and a secondary dislocation of a screw at the distal radius.

Treatment and outcome

The patient's orthopedic surgeon recommended to operate on the olecranon fracture on the right side and to remove the screw from the left wrist. The operations were performed 13 days after the accident. For a dorsal approach to the elbow, the patient was placed in a lateral position. The skin was incised over the proximal ulna over a length of about 15 cm. The fascia was then split longitudinally and the musculature was sparsely detached from the bone on both sides of the proximal ulna. The hematoma was evacuated and the fracture surfaces were cleaned. The depressed articular fragment was elevated using a chisel. Then the olecranon was reduced by traction on 2 previously braided sutures in the triceps tendon and provisionally stabilized with a Kirschner wire. A 2.8-mm curved plate was then applied to the radial side, proximally slid under the triceps muscle, and fixed with a 50-mm cortical screw in the most proximal hole. Afterward, a second plate was

Ethical committee approval was not necessary because both patients of this case report consented to the publication of their medical history and pictures in a scientific journal.

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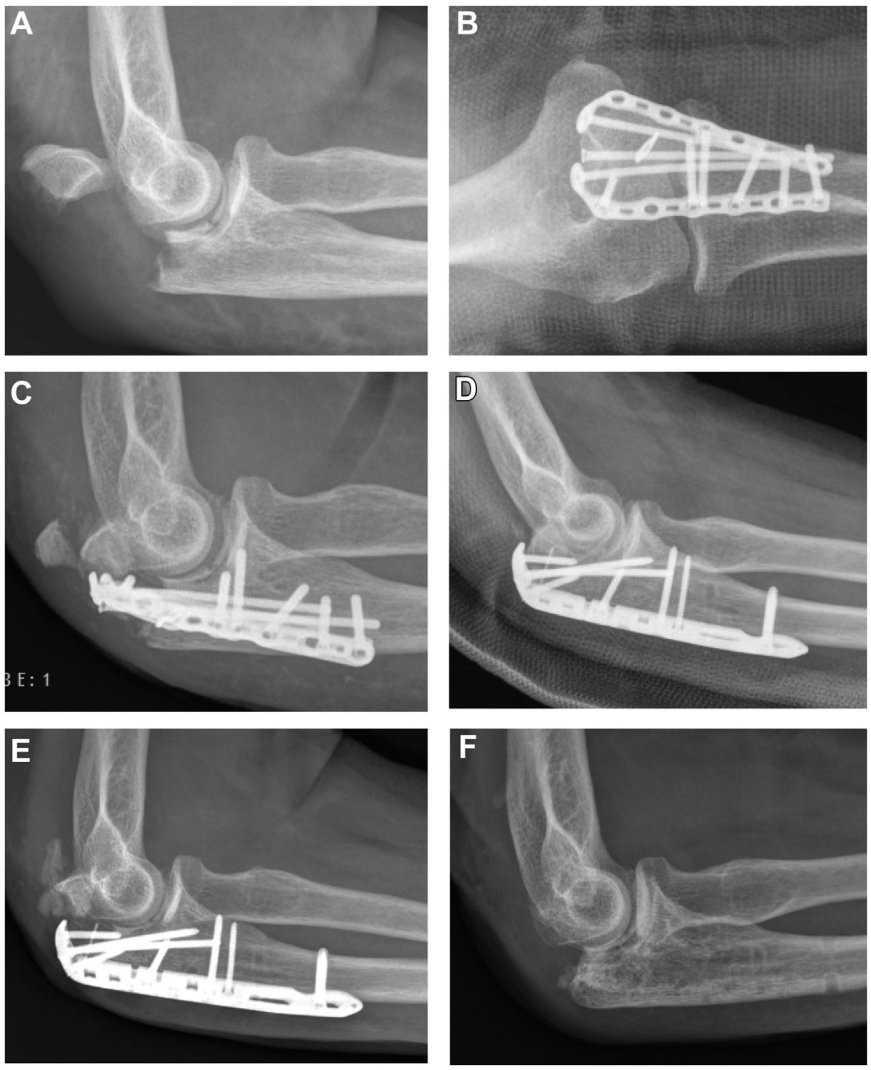

Figure 1 Radiographs of the right elbow of patient 1, (**A**) taken after the fall, (**B**) after double-plate osteosynthesis, (**C**) 6 weeks after surgery, (**D**) after revision surgery with a dorsal locking compression plate, (**E**) 2 weeks after revision surgery, and (**F**) 6 weeks after hardware removal and excision of the dislocated fragments.

placed on the ulnar side. The triceps tendon was again incised so that the plate could be applied to the bone and also fixed with a 50-mm screw. A small gap on the dorsal side between the olecranon and the proximal ulna was filled with a bone chip. The osteosynthesis was completed with 2 additional screws in the olecranon and 5 screws in the proximal ulna. A broken drill bit was left in the bone. The sutures in the triceps were secured to the plate. Intraoperative X-ray images showed that the fragments and hardware were correctly positioned (Fig. 1, *B*). The wound was closed in layers and the elbow was immobilized in an upper arm cast in 90 degrees of flexion. Ten days after the procedure, the patient had to be hospitalized for dyspnea associated with COVID-19 infection. Other diagnoses included asthma, type 2 diabetes, hypokalemia, and folic acid deficiency. Previous medical problems included a pulmonary embolism, spondylodesis L4-L5 and L5-S1, a consecutive epidural staphylococcus epidermidis infection, a malleolar fracture, and the above-mentioned wrist fracture. The patient gradually recovered with oxygen, cortisone, and breathing therapy. The stitches on the elbow were taken out during hospitalization. No joint mobilization was performed until the cast was removed after 6 weeks. At this point, the radiographs showed a secondary dislocation of the olecranon tip (Fig. 1, *C*) and the surgeon recommended a reoperation. The hardware was removed. An additional longitudinal split of the dislocated olecranon tip was found intraoperatively. The fragments were reduced as well as possible and held together with a small transverse screw. Afterward, the so reconstructed olecranon was reduced against the ulna and held in place with a precontoured 2.7-3.5-mm dorsal olecranon plate. The latter was fixed with 4 screws proximally and 4 screws distally (Fig. 1, *D*). The construct was additionally secured with 4 sutures that passed through the triceps tendon and the plate holes. The elbow was again protected with a cast. X-rays taken 2 weeks later when the stitches were removed showed that the fragments had dislocated again (Fig. 1, *E*). The patient was instructed to wear the cast for another 4 weeks. Three months after revision surgery the family doctor referred the patient to us for a second opinion. She reported ongoing pain and was disabled by restricted mobility. The elbow flexion was 115°, extension deficit was 30°, and pronation and supination were normal. The extension force could not be objectified because of pain. Given the previous 2 failures, we did not consider a third osteosynthesis attempt. We advised the patient to continue with rehabilitation, to use the elbow as much as possible, and, if necessary, to have the hardware removed later. Over the following weeks, the range of motion improved significantly, but the pain did

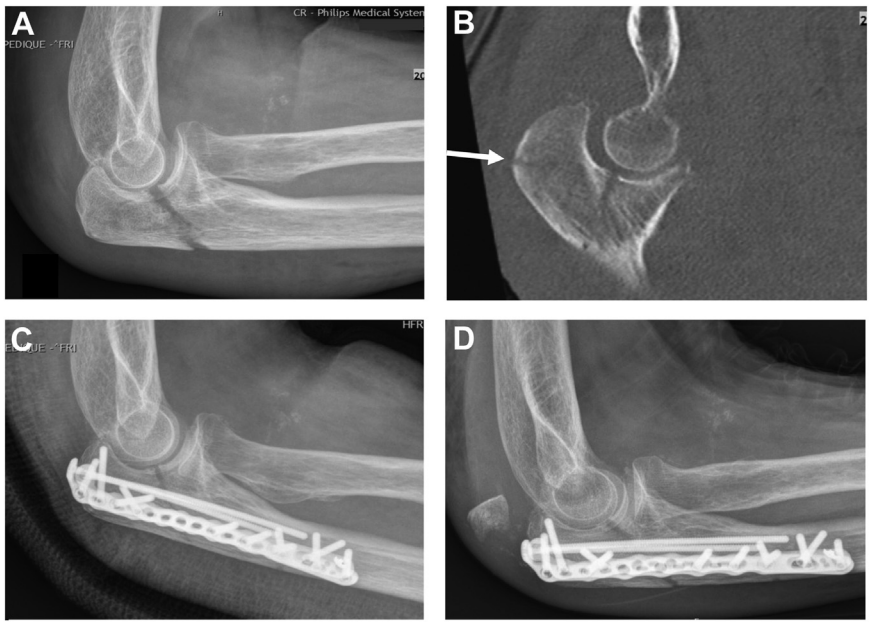

Figure 2 Radiographs and computed tomography scan of the right elbow of patient 2, (**A** and **B**) taken after the fall, (**C**) after the double-plate osteosynthesis, and (**D**) 6 weeks postoperatively. The *white arrow* in (**B**) shows the additional fissure in the olecranon tip.

not disappear. Accordingly, we removed the hardware and the tip of the drill bit 6 months after the revision surgery. Several screws were sent in for microbiological analysis and were found to be sterile. The extensor mechanism had a small gap through which the dislocated olecranon fragments could be palpated. Medially and laterally, the triceps tendon was in continuity with the ulna via scar tissue. The bone fragments were carefully removed and the gap in the extensor mechanism was closed side to side. After wound closure, a slight compression bandage was applied for 3 days and the patient was instructed to move her elbow actively and passively but not to put any weight on it for 6 weeks. After this time, the patient was pain-free and satisfied with the result (Fig. 1, *F*). She was able to bend her elbow 145 degrees and to pronate and supinate the forearm normally. The extension deficit was 10 degrees and did not bother the patient. At the final follow-up 4 months postoperatively, she was no longer restricted in her daily life and was able to use her trekking poles without any problems.

Case 2

Patient history

A 90-year-old right-handed woman living in a nursing home fell on her right side and sustained a slightly dislocated olecranon fracture (Fig. 2, *A*). Sagittal computed tomography images of the elbow showed a second undisplaced fracture more proximal to the main fracture (Fig. 2, *B*). Ten years earlier, her right shoulder was treated with an inverse prosthesis with good results. The shoulder was not injured in the fall.

Treatment and outcome

Surgical treatment was recommended and a low-profile double-plate osteosynthesis was made according to the technique described above (Fig. 2, *C*). The elbow was then protected in a cast. Radiographs made at the 6-week follow-up control revealed a secondary dislocation of the olecranon tip (Fig. 2, *D*). The patient's relatives requested a second opinion. Due to the good results of conservatively treated olecranon fractures in elderly patients,[3] we advised against a revision surgery and recommended to observe the further course. Shortly thereafter, the patient fell again and complained of more pain for a while. A few weeks later, she was asymptomatic again and had a range of motion that was sufficient for her activities. The range of motion and extension force were not measured, but the patient was able to dress and undress herself, to eat by herself, and to go around with her walker. She did not request any metal removal.

Discussion

Surgical treatment of olecranon fractures is problematic due to the thin soft tissue envelope covering the bone. Most implants irritate the skin or bother the patients when placing the elbow on a hard surface and have to be removed after successful bone healing. Hardware removal is usually not difficult, but it is inconvenient and associated with risks for the patient and with costs for the health-care system. Therefore, low-profile double-plate osteosynthesis was recently introduced. Ellwein et al[2] reviewed 22 patients treated with a locking compression plate (LCP) and 25 patients with a low-profile double plate. They reported that 8 patients (36%) in the LCP group and 7 patients (28%) in the double-plate group required metal removal. They concluded that soft tissue irritation still remains an issue. In the study by Qi et al,[9] on the other hand, only 2 of 28 patients (7%) treated with the double-plate technique requested metal removal. This was significantly less than in the TBW (34%) and the LCP groups (25%).

Whether the other advantages of double-plate osteosynthesis emphasized by manufacturers and users also apply has yet to be proven. Siebenlist et al[10] were of the opinion that using more screws and bicortical fixation increased stability of the proximal fragments. This may be true in theory and with excellent bone quality. However, placing several screws in small olecranon fragments of elderly patients carries the risk of further weakening the bone. In the first case described above, at least 6 holes were drilled: 1 for the temporary Kirschner wire and 5 for the screws, although only 4 could be used because of a broken drill bit. In the second

case, at least 7 holes were drilled into the olecranon and 6 of them were filled with screws. This appears to be a lot.

Other factors related to the implants or the surgical technique may have contributed to the failures of the osteosynthesis. The surgeon reduced the olecranon indirectly by applying tension to sutures placed through the triceps tendon, avoiding the use of a reduction forceps, likely to protect the bone. The fracture was then stabilized with 2 cortical screws inserted through the proximal plate holes, oriented longitudinally. Since no gliding holes were created, interfragmentary compression could not be achieved. This would also not have been possible with the plates, as the holes were not designed for dynamic compression. As a result, a fracture gap remained visible on the intraoperative and postoperative radiographs of both patients. Interfragmentary compression, however, would have been crucial for the stability of the construct and for bone healing.

In addition, the placement of the implants is biomechanically suboptimal. Unlike the classic TBW or dorsal plate osteosynthesis, the double plates are not positioned on the tensile side of the bone. Instead, they are applied laterally and medially, with their proximal ends positioned further ventrally on the olecranon, beneath the muscular insertion of the triceps. Consequently, the strong superficial triceps tendon is not neutralized, increasing the risk of the fracture gap opening as elbow flexion increases.

Rehabilitation and patient compliance also play an important role in the success of an operation. Some surgeons recommend early functional mobilization to prevent stiffening of the joint.[4] Others prescribe a removable elbow cast to prevent the patient from moving or loading the elbow in an uncontrolled manner. With or without a cast, it is important to advise the patient not to use the operated arm to stand up or sit down. Extension loading of the forearm activates the triceps muscle, which pulls on the refixed olecranon. Both patients described in this report were receptive and mentally in good condition. However, whether they had been informed and whether they had followed the recommendations of their surgeon cannot be verified.

Our 2 cases confirm that the conservative treatment of displaced olecranon fractures in elderly patients can lead to good clinical results and a high level of patient satisfaction.[1,3,8,11] In the first case, the end result after 3 operations was roughly the same as it would have been with conservative therapy. The patient is now pain-free and can use her arm normally in her daily life. The slight deficit in extension and the slightly reduced extension strength do not prevent her from using trekking poles. The second patient was older, less active, and dependent on a walker. The surgical treatment of her olecranon fracture was a burden for herself and her family and did not solve the problem. After the pain subsided, she was able to use her arm and walking aid again, despite the redislocation of the olecranon. Accordingly, nonoperative treatment may have resulted in a similar outcome without the risk of surgical management in this case either.

In the studies by Ellwein et al[2] and Qi et al,[9] all fractures healed. However, Ellwein et al[2] had to revise 2 patients in the double-plate group because of intra-articular screws. It is very likely that additional or other complications have occurred in other clinics but have not yet been published. To assess and improve a new procedure, all problems that arise with it should be consistently reported.

Conclusion

The 2 cases described above show that double-plate osteosynthesis is not complication-free. The use of numerous screws for the fixation of the olecranon and the absence of the tension band principle can result in failures, particularly in elderly patients with reduced bone quality.

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