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ORIGINAL ARTICLE

Headless Compression Cannulated Screw Combined with Radial Head Replacement for Terrible Triad of the Elbow: A Case Report and Literature Review

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Introduction

According to domestic and foreign literature reports, terrible triad of the elbow is a complex injury of multiple fractures and dislocations of the elbow caused by high-energy impact. In the early 1990s, the treatment of terrible triad of the elbow was mostly conservative. It was often difficult to maintain the stability of the elbow, and there was a risk of re-dislocation, and the prognosis was[1] often not satisfactory. At present, the "terrible triad" of the elbow is almost all treated with active surgery, and with the improvement of surgical techniques and the standardization and stylized treatment, the excellent and good prognosis rate is gradually increasing[2] . However, there are still many patients with poor functional recovery of the elbow after operation. The author successfully treated a patient with terrible triad of the elbow by using headless compression cannulator screw combined with artificial radial head replacement in 2024, and achieved very satisfactory results. This report is as follows.

1 Case data

A 41-year-old female patient was admitted to the hospital due to pain in the right elbow joint with limited movement for 3 hours after a fall. The patient had fallen from a height more than 3 hours earlier, and immediately felt excruciating pain in her right elbow. The exact mechanism of injury was unknown. He denied primary and secondary coma, and had no nausea, vomiting, chest tightness, palpitation, dyspnea, abdominal pain, or abdominal distention. After injury, the patient was sent to a local hospital for treatment, and symptomatic treatments such as imaging examination and infusion were given. He was transferred to our hospital for further diagnosis and treatment. After emergency imaging examination, he was admitted to our department with the symptoms of "1. Dislocation of the right elbow joint 2. Since the onset of the disease, the patient had good appetite and sleep, normal stool and stool, and no significant change in weight.

The patient's consciousness was clear, bilateral pupils were symmetrical and equal, and he was sensitive to light reflex. There was no obvious tenderness in the chest and abdomen, the right elbow joint was elastic fixed like extension, with significant swelling and tenderness, and the movement of the right elbow joint was limited. CT scan and three-dimensional reconstruction of

the right elbow joint showed: 1. Posterior dislocation of the right elbow joint; 2. Fracture of the right ulnar coronoid process and radial head (Figure 1).

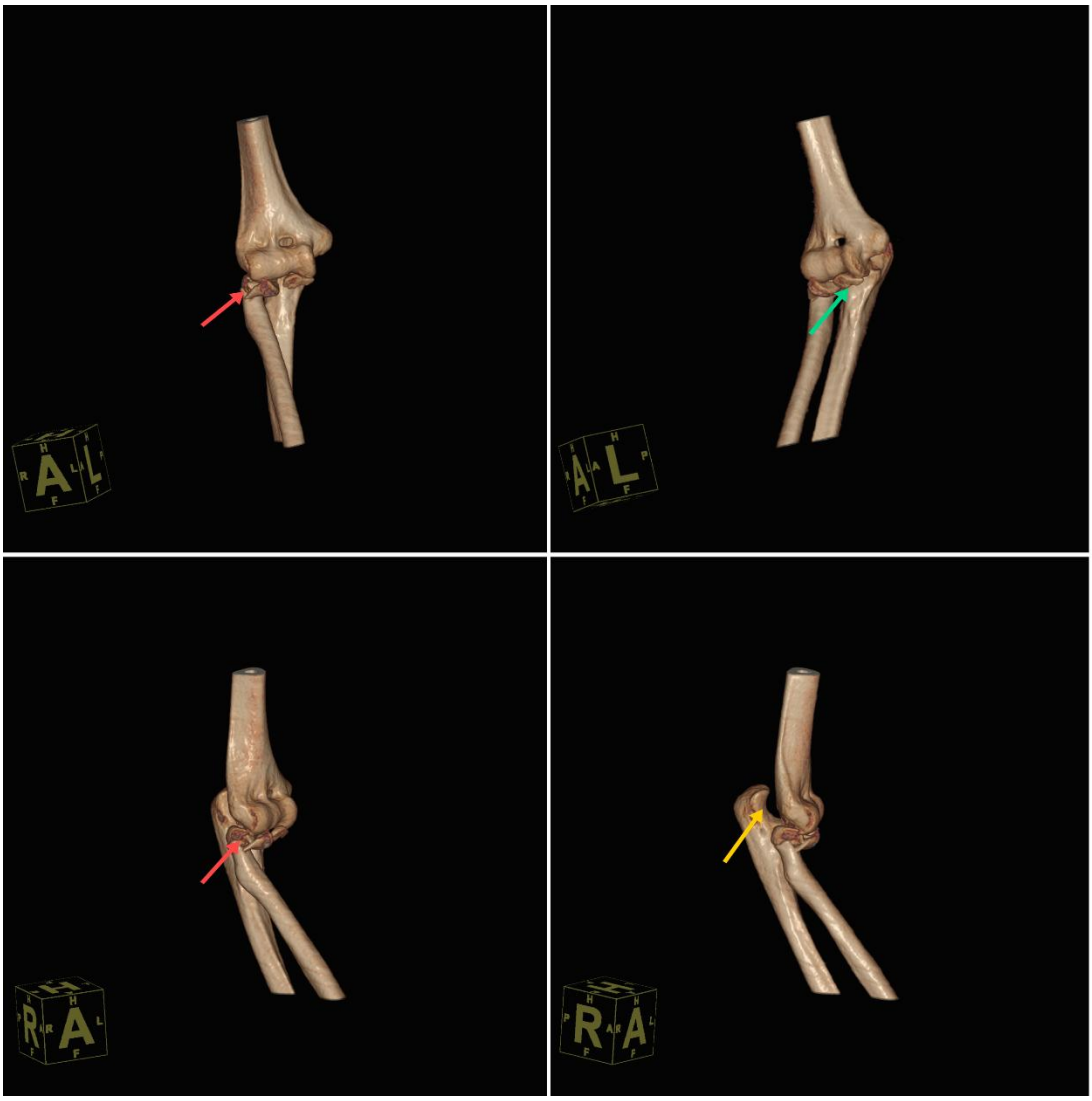

Figure 1 Preoperative CT+ 3D imaging of the elbow joint showing posterior dislocation of the right joint (yellow arrow), comminuted fracture of the right radial head type III (red arrow), and fracture of the right ulnar coronoid process type III (yellow dashed line).

Diagnosis in our department: (1) posterior dislocation of right elbow joint; (2) type III fracture of right ulna coronoid process; (3) type III comminuted fracture of the radial head.

Due to the elbow dislocation, extension-like elastic fixation, significant swelling, obvious tenderness, and limited movement of the right elbow joint, emergency reduction of the elbow joint was performed. Considering that the patient was a middle-aged patient with high requirements for elbow joint function, and after good communication between doctors and patients, right radial head replacement + reduction and internal fixation of right ulnar coronoid process fracture incision + vascular nerve exploration was performed. The surgical procedure: After anesthesia was satisfied, the patient was placed in the supine position, the right upper limb root was bound with a tourniquet, the operation area was sterilized and covered with iodine, and a longitudinal incision of about 8cm in length was made along the right lateral epicondyle of the humerus oblique down, the skin and subcutaneous soft tissue were separated layer by layer, and the deep branch of the radial nerve was protected through the anconeus muscle and extensor carpi ulna tendon, and the injuries of the right radial head and its surrounding were explored. The medial and lateral collateral ligaments of the right

elbow joint were injured; The forearm pronation was performed to protect the dorsal interosseous nerve. The proximal end of the radius was exposed by incision of the joint capsule, and the fracture fragments of the radial head were removed. The radial neck was cut off at about 5mm above the radial trochanter by pendulum saw, and the section was trimmed by bone file. The reamer was used to manually rewire the bone from small to 5.5mm to the inner edge of the cortex. The fracture fragments of the radial head were pieced together and reduced. The test model was removed, the incision and the radial marrow cavity were rinsed with a large amount of normal saline, the 5.5 +2 metal handle and 20mm metal radial head prosthesis were installed, the joint prosthesis was repositioned, and the joint stability was checked again. There was no impact and dislocation between the prosthesis and the surrounding tissues during flexion and extension activities. The joint surface of the prosthesis was in good contact with the head of the humerus, the pressure was moderate, the position of the prosthesis was good by C-arm fluoroscopy, the fracture fragments were removed without residue, the wound was washed with normal saline, and an absorbable barbed suture was used to suture the incision layer by layer. A longitudinal incision of about 5cm was made along the median of the right elbow joint, the skin and subcutaneous soft tissue were separated layer by layer, and the blood vessels and nerves on the anterior side of the elbow joint were protected. The fracture of the ulna coronoid process was exposed, the blood clots and small bone fragments in the joint cavity were removed, the fracture broken end was reduced, the fracture broken end was fixed with the cannulated screw positioning needle, and two 2.7×26mm hollow countersunk head screws were inserted. The fracture reduction and fixation were examined, and the C type wall fluoroscopy was used to confirm the reduction. Normal saline was used to wash the wound, and the incision was sutured layer by layer. The tourniquet was loosened. The patient was satisfied with the anesthesia during the operation, and the operation was smooth. About 50ml was produced during the operation, and the breathing was strong after anesthesia and the vital signs were stable. Postoperative routine infection prevention, dehydration and detumescence, analgesic treatment, oral indomethacin to prevent heterotopic ossification. The elbow joint was fixed in the neutral position of the forearm with an adjustable brace, and the passive movement of the forearm under the guidance of rehabilitation doctors began on the second day. The range of flexion and extension of the elbow joint was set at 60-100 ° within 2 weeks, 30-120 ° at 3 to 4 weeks, and the normal range as far as possible at 4 weeks. The adjustable brace was removed at 4 weeks after operation, and then the active strength functional exercise was started. (Figure 2).

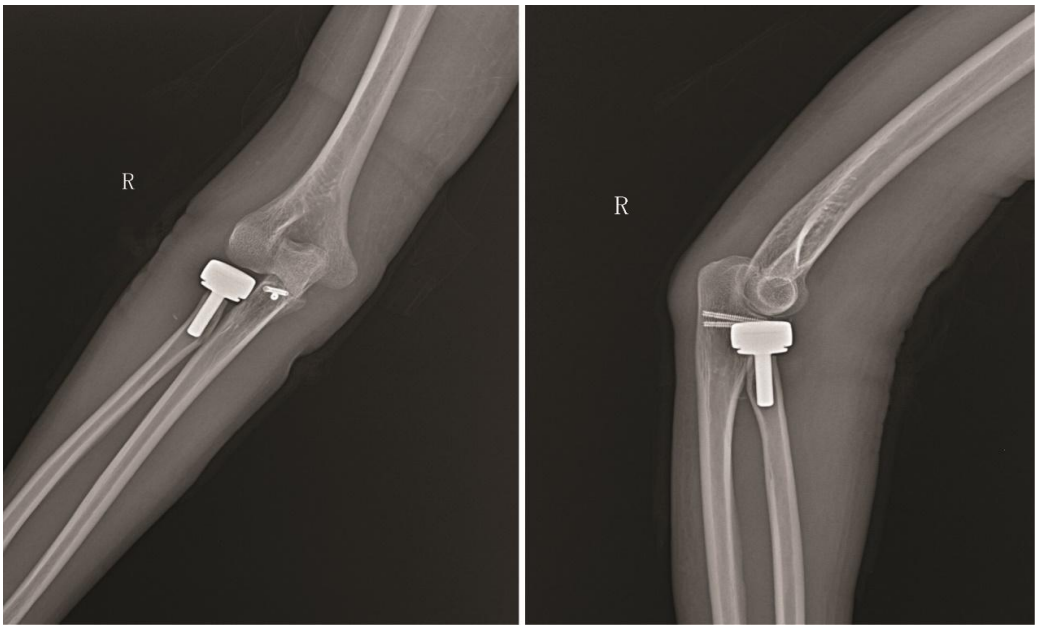

Figure. 2 Postoperative X-ray films showed that the internal fixation was in position, and no prosthesis loosening or internal fixation failure was observed

2 Discussion

The ligament tissue around the elbow joint includes the medial collateral ligament complex (MCLC) and the lateral collateral ligament complex (LCLC). The medial collateral ligament complex is composed of three small ligaments with different orientations: anterior bundle, posterior bundle, and transverse bundle. The lateral collateral ligament complex consists of four small ligaments: lateral ulnar collateral ligament (LUCL), lateral ra-dial collateral ligament, annular ligament, AL), accessory lateral ligament (accessory lateral ligament). The stability of the elbow is mainly provided by the radial head, ulna coronoid process, lateral collateral ligament complex, and the anterior bundle of the medial collateral ligament complex. The terrible triad of the elbow refers to the simultaneous occurrence of radial head fracture, ulnar coronoid process fracture, and posterior dislocation of the elbow joint, often combined with collateral ligament injury. Studies have shown that patients with elbow dislocation are accompanied by lacerations of the medial and lateral collateral ligaments. Fedorka et al.[3] believed that when there is a simultaneous extension and abduction of the elbow joint, forearm supination, and huge axial impact, the olecranon is easy to detangle from the humeral trochlea, resulting in posterior dislocation, in which muscles, ligaments, joint capsules, and other structures are damaged and torn. At the same time, the lateral collateral ligament, the anterior and posterior joint capsule, and the medial collateral ligament are injured in succession in the process of the complex injury[4] . According to Mason classification, radial head fractures were classified into three types: type I : non-displaced fractures; Type II : displaced two-part articular fracture; Type III : complex fracture involving the whole radial head. On this basis, Hotchkiss[5] modified the classification according to clinical examination and intraoperative findings. In the modified Hotchkiss classification, type I was defined as displacement < 2 mm without mechanical block; Type II : displacement > 2 mm and still repairable; Type III is a complex fracture that is difficult to repair and often requires radial head resection or replacement.

The main surgical treatments for radial head fractures include radial head resection, open reduction and internal fixation, and radial head replacement. The indications for radial head resection are as follows: (1) damage of the radial head less than 25%; (2) the fragments are too small; (3) Severe osteoporosis; (4) The fracture fragments did not involve the proximal radioulnar joint; However, the coronoid process and collateral ligament need to be effectively repaired to ensure the stability of the joint. In the early studies of elbow fracture and dislocation, only radial head fracture was reported. After reduction, many scholars recommend early radial head resection, but there are also views that radial head resection will bring a series of complications and lead to poor function. In a 2002 study by Ring et[6] al., 11 patients with terrible triad of the elbow were followed up, 4 of whom underwent radial head resection, 3 of whom had no repair of the lateral collateral ligaments. Elbow instability occurred in 5 of the 11 patients, 4 of whom were treated with radial head resection. If the radial head fracture can be repaired, plate, compression screw, and traditional countervaded screw can be used. The typical internal fixation method is temporary Kirschner wire fixation after reduction, and countervaded screw with a diameter of 1.5 mm, 2.0 mm, or 2.4 mm can be inserted. Cannulated screws can also be used in non-complicated fractures of the radial head and neck, and their guide pins can prevent sliding between the screws and the medial cortical bone. If the radial neck fracture is comminuted, the use of a plate should be considered for internal fixation. The plate should be placed away from the proximal radioulnar joint, which Ikeda M et al. referred to as the "safe zone." In fractures involving the radial neck, the interosseous nerve of the forearm is easily injured during the operation. Therefore, special attention should be paid to the distal incision. The authors suggested that type I and type II fractures should be fixed with one or two Herbert screws with flat ends, and those with radial neck fractures should be fixed with mini-plates. Type III fractures should be fixed with multiple 1.5 mm Kirschner wires after restoring the general contour. Radial head replacement should be considered in patients with extensive radial head fractures, comminuted fractures of the radial neck, or severe osteoporosis. The radial head prosthesis should be based on the resected fragment of the radial head. At the same time, the height of the radial head

prosthesis should be consistent with the thickness of the resected bone fragment in order to prevent the influence of the prosthesis on the range of motion of the joint. The ideal position of the radial head is about 2mm distal to the tip of the coronoid process. Recently, Leigh et[7] al. compared the clinical data of patients with terrible triad of the elbow treated by radial head fixed repair and radial head replacement. After an average follow-up of 41 months, there was no significant difference in the range of motion between the two methods, but the DASH score of the replacement group was significantly higher than that of the radial head fixed repair group. However, they believe that although the complication and reoperation rate of radial head repair is higher than that of radial head replacement, radial head repair should be the first choice for young patients as much as possible. Turner et al. found that repair of the radial head with autologous or allogeneic bone may be an alternative to prosthetic replacement. They used allogeneic bone to partially replace the radial head in 8 patients with complex fracture and dislocation of the elbow, and clinical and imaging examinations showed good fracture healing after dozens of months of follow-up. Since this patient was a type III complex comminuted fracture of the radial head that was difficult to repair, the author believes that the key to the treatment of this case is to reconstruct the stability of the elbow joint and preserve the maximum range of motion of the joint.

In terrible triad injury of the elbow, the medial collateral ligament is usually torn, and the radial head is an important stable structure to resist the valgus and posterior dislocation of the elbow. At present, scholars have reached a consensus that in the treatment of terrible triad of the elbow, simple radial head resection should be avoided as far as possible. However, in this case, the patient is young and has high requirements for elbow joint function. Considering that the radial head fracture is a complex type III radial head fracture that is difficult to repair and has many late complications, radial head replacement is performed. This operation attempted to implant the radial head prosthesis with a larger contact surface, so as to obtain better stability of the elbow joint by increasing the joint contact area. No joint slippage or instability was found during the operation, and the collateral ligament was not repaired by conventional joint capsule repair.

In terms of coronoid process fractures, Regan and Morrey were the first to put forward the classification of coronoid process fractures. In the Regan and Morrey classification, the main classification was based on the size of the coronoid process fracture. Type I refers to the laceration fracture of the coronoid process tip; Type II refers to fracture fragment less than 50%; Type III was defined as a fracture fragment larger than 50% of the whole coronoid process. On this basis, they were divided into two subgroups according to the presence or absence of fracture displacement: subtype A and subtype B. According to the anatomical location of the fracture, O 'Driscoll et al.[8] proposed another classification method, which divided the coronoid process into three parts: the tip, the anteromedial side, and the base. The coronoid process tip fracture was divided into two subtypes according to whether the fracture fragment was > 2 mm or not. Therefore, the medial collateral ligament is generally intact at the ulna attachment point. The anteromedial coronoid fractures can be divided into three subtypes. Subtype 1 does not accumulate the tip, involving the medial part of the tip to the anterior part of the apical tubercle. Subtype 2 was subtype I fractures involving the tip; Subtype 3 involved the anteromedial margin and apical tuberosity. The extent of the basal part of the coronoid process was at least 50% of the total height. Subtype 1 only involved the coronoid process, and subtype 2 combined with olecranon fracture.

The coronoid process, as one of the important structures for the stability of the brachioulnar joint, needs at least half of the height of coronoid process to ensure the stability of the sagittal plane of the brachioulnar joint. Therefore, whether the fracture exceeds 50% of the coronoid process is an important reference standard for the selection of fixation methods. Small coronoid process apex fractures can be fixed with non-absorbable sutures or combined with anchors. Pai et al.[9] used suture anchors to fix coronoid process, anterior joint capsule and lateral collateral ligament and replace the radial head in 6 patients with terrible triad of the elbow, with satisfactory results. Moderate coronoid process fractures can be fixed with lag screws. Some scholars have suggested that cannulated screws can be used to fix the coronoid

process fractures from backward to forward. In 40 patients with terrible triad of the elbow, Garrigues et[10] al. compared the efficacy of suture lasso fixation combined with lag screw or suture anchor fixation for the treatment of coronoid process fracture, and the results showed that the former had higher stability and fewer postoperative complications.

Although most coronoid process fractures in terrible triad of the elbow are type I fractures, Beingessner et[11] al. found that for type II and III coronoid process fractures, as the size of the fracture fragment increased, the varus angulation and varus and valgus flaccidability also increased. They suggested that the fractures of type II and III should be fixed by screw plate as precisely as possible, and the lateral collateral ligament should be repaired at the same time. "Regan and Morey[12] suggest that the risk of elbow dislocation, treatment failure, and stiffness increases with the size of the fracture block, and they suggest that fragment fixation is required for coronoid fractures > 50% in height." At the same time, 15 patients with terrible triad of the elbow were treated with mini-T plate fixation, and the medial and lateral collateral ligaments were repaired at the same time. After an average follow-up of 14 months, the excellent and good rate reached 86.7%, and no elbow instability occurred. However, a few researchers use cannulated lag screws to fix the coronoid process and repair the medial and lateral collateral ligaments of the elbow, and the patients get good function after operation. They believe that cannulated lag screws are more practical for the treatment of this kind of injury, and 2 to 3 cannulated lag screws can fix it well and meet the needs of early mobilization. For this patient with type III fracture of the right ulna coronoid process, we used a longitudinal incision along the median of the right elbow joint, separated the skin and subcutaneous soft tissue layer by layer, protected the blood vessels and nerves of the elbow joint, exposed the fracture end of the ulna coronoid process, cleaned up the blood clots and small bone fragments in the joint cavity, reduced the fracture end, and fixed the fracture end with cannulated screws. Two 2.7×26mm hollow countersunk head screws were implanted, and the compression fixation was good.

There are many postoperative complications in terrible triad, and the incidence is closely related to the severity of the injury. The common complications include elbow instability, malunion, nonunion, joint stiffness, heterotopic ossification, infection in the surgical area, and ulnar nerve symptoms.

Elbow instability: It was previously believed that Regan and Morrey type III coronoid process fractures were more frequently associated with elbow instability. However, currently, Regan and Morrey type I and II coronoid process fractures are more likely to have elbow instability. The theory is that this is caused by damage to the associated ligaments around the elbow and the difficulty of effective internal fixation of these small fracture fragments. According to relevant reports, chronic elbow instability is more common in coronoid process fractures with small fracture fragments, especially when combined with radial head fractures, they suggest that, They believe that even small coronoid fracture fragments have attachment to the anterior joint capsule of the elbow, so effective fixation of the fracture fragment is helpful to improve the stability of the elbow.

Joint stiffness: Traumatic joint stiffness is a complication with a high incidence after the operation of terrible triad. The ideal treatment is to "prevent the disease before it occurs", that is, to ensure that the elbow joint can maintain stability during early activities. If elbow stiffness has occurred, the first choice of treatment is conservative treatment, namely passive stretching training and static gradual splinting. If the joint stiffness is stubborn, screw buckle splinting can be considered. Elbow stiffness that fails to respond to conservative treatment can be released by open capsulotomy or arthroscopic surgery.

Other common complications include post-traumatic arthritis and infection. The main treatments include debridement, radial head resection or replacement, or total elbow replacement. Infection is also a potential risk and can be treated with oral or intravenous antibiotics. Further debridement and the addition of intravenous antibiotics should be performed if necessary.

In this case, radial head replacement and cannulated nail locating needle fixation for the treatment of terrible triad can not only shorten the

operation time, but also obtain excellent clinical efficacy. With stable joint movement and fracture fixation, early postoperative rehabilitation training can be carried out, which can significantly improve the elbow joint function and medical satisfaction of patients.

Terrible triad of the elbow has always been a difficult problem for orthopedic surgeons due to the complex anatomical structure and injury mechanism. In order to achieve exact and effective reduction and fixation, and restore the anatomical structure of the elbow as much as possible, surgery is generally the main treatment plan. In the future, the injury mechanism of terrible triad needs to be further clarified. The repair and fixation of soft tissue and fracture fragments, especially whether the medial collateral ligament should be routinely repaired and reconstructed, needs to be further explored. The choice of surgical approach and flap protection need to be further improved. There are many complications after the operation of terrible triad, and the prevention and treatment of functional recovery exercise and complications need to be further improved.

In conclusion, for patients with terrible triad of the elbow, clinicians should consider the patient's condition comprehensively and propose personalized treatment for patients. The successful treatment of this case provides a certain reference and guiding significance for patients with such complicated conditions in the future.

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