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Origional Article

Minimally Invasive Internal Fixation for Gustilo Type III Opening Ankle Fracture with Dislocation: A Case Report and Literature Review

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Introduction

With the development of modern transportation industry, the incidence of opening ankle fracture with dislocation caused by high-energy injury is increasing year by year. There are many clinical reports of complications caused by improper treatment, such as skin necrosis, wound infection, traumatic arthritis, malunion, etc. Moreover, opening injury is often combined with other fractures and organ injuries, and the condition is generally more critical. Its treatment is also controversial, and the treatment program has become an urgent clinical problem to be solved. According to domestic and foreign literature reports, Gustilo type III opening ankle fracture with dislocation is a composite injury of multiple ankle fractures and dislocations caused by high-energy impact. Most of these patients have severe soft tissue injury and are prone to necrosis and infection. Traditional treatment usually combines limited internal fixation and external fixation to assist fixation, which can ensure the treatment of opening soft tissue injury, reduce the incidence of infection, and directly observe the condition of the limb or wound, which is helpful for later treatment. However, there are still many side effects such as ankle stiffness and poor functional recovery after external fixation, so the treatment of opening ankle fracture with dislocation needs to be explored urgently by medical workers. In 2025, the author used minimally invasive internal fixation to treat a case of Gustilo type III opening ankle fracture with dislocation, and achieved very satisfactory results.

1 Case Data

A 61-year-old man was admitted to the hospital due to bleeding, pain and limited mobility of the right ankle for 2+ hours after a fall. The patient accidentally fell from a ladder while cleaning at home 2+ hours ago, resulting in bleeding, pain, swelling, and limited movement of his right ankle. The specific mechanism of injury was unknown. There was no nausea, vomiting, chest tightness, palpitation, dyspnea, abdominal pain, abdominal distention, etc. After injury, he was sent to our hospital for emergency treatment, and the relevant examinations were completed. He was admitted to our department with an opening fracture and

dislocation of the right ankle. Since the onset of the disease, the patient had good appetite and sleep, normal stool and stool, and no significant change in weight.

Physical examination at admission: T:36.5℃, P:86 times/min, R:18 times/min, BP:123/88mmHg. Clear consciousness face: acute illness posture: autonomous. Skin is normal. Superficial lymph nodes were not palpable throughout the body. The cardiac boundaries were normal and rhythmic, and no pathological murmurs were heard in any of the valve regions. The chest was normal, with normal respiratory rhythm, normal intercostal space, no nodules or masses on the chest wall, and no sternal percussion. Both lungs were voiceless on percussion. The breath sounds in both lungs were clear, and no dry or wet rales or pleural frictions were heard in both lungs. There was no obvious abnormality in speech conduction. The abdomen was soft and normal in appearance, with no tenderness or rebound tenderness. The liver was not palpable subcostal, the spleen was not palpable subcostal, and the kidneys were not palpable. Specialist examination showed a wound of about 15cm in length on the lateral side of the right ankle, with local bleeding, exposed fracture end, severe cartilage injury, complete dislocation and deformity of the ankle joint, obvious local soft tissue swelling, subcutaneous bruising and swelling of the right dorsum of the foot, obvious local tenderness, limited movement of the right foot, and good pulse of the dorsal artery of the right foot. Auxiliary examination: CT scan of the right ankle joint and three-dimensional reconstruction showed: 1. Dislocation of the right talocalcaneal joint and talonavicular joint; 2. Fracture of right calcaneus and talus; 3. Fracture of the right scaphoid and cuboid (see Figure 1). Diagnosis in our department: 1, opening ankle fracture with dislocation (Gustilo type III) 2, right talocalcaneal and talonavicular joint dislocation 3, right calcaneal and talus fracture 4, right scaphoid and cuboid fracture 5, right calcaneofibular ligament rupture 6, ankle joint cavity hemorrhage.

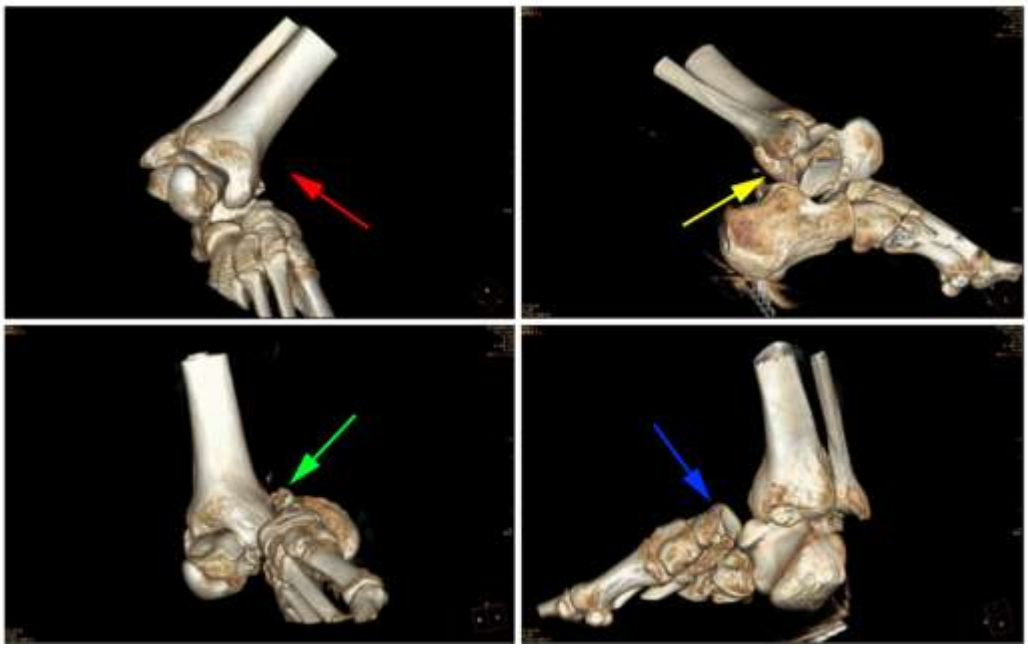

Figure 1 Preoperative ankle joint CT+ three-dimensional imaging: right ankle joint dislocation (red arrow), right talocalcaneal joint dislocation (yellow arrow), right talus comminuted fracture (green arrow), right talonavicular joint dislocation (blue arrow)

In view of the patient's opening ankle fracture with dislocation (Gustilo type III), it is an opening ankle fracture with dislocation, and the local contamination is light, one-stage debridement and suture can be considered. For the patient's fracture and dislocation, after the discussion of the department, it was recommended to perform one-stage complete debridement, reduction and fixation, and repair the ruptured right calcaneofibular ligament at the same time. After improving the relevant preoperative preparation and good doctor-patient communication,

emergency debridement of right ankle opening injury + opening reduction and internal fixation of talocalcaneal joint and talonavicular joint dislocation + ankle joint debridement, vascular nerve exploration, calcaneofibular ligament repair and ankle joint stabilization were performed. The procedure of operation: after the patient was satisfied with anesthesia, he was placed in the supine position, and the right thigh proximal end was bandaged with a tourniquet. The operation area was sterilized with iodopor and a mattress was placed. Intraoperative findings: opening fracture of the right ankle joint, opening dislocation of the right talocalcaneal joint and talonavicular joint, exposure of the talus, rupture and partial residue of the calcaneofibular ligament, partial stripping and defect of the articular cartilage of the talus, possible injury of the medial collateral ligament, obvious bleeding of the right ankle wound, about 15 transverse wounds in length, and strong pulse of the right dorsal artery of the foot. The opening wound of the right ankle joint was rinsed with hydrogen peroxide, normal saline, and iodophor, rinsed with a large amount of normal saline pulse, trimmed the skin margin, cleaned the broken articular cartilage in the joint cavity, trimmed the stripped cartilage of the talus, reduced the talocalcaneal joint and talonavicular joint, and explored the blood vessels and nerves. No obvious injury was found. Two 2.0 titanium Kirschner wires entered from the medial and lateral edge of the foot respectively, penetrated the calcaneus, talus and tibia on the lateral side, and penetrated the talus and scaphoid on the medial side to stabilize the talonavicular and talonavicular joints. Examination showed that the reduction and fixation of the joint fracture and dislocation were good. A metal wire anchor was used to reconstruct the calcaneofibular ligament, and the examination showed that the ligament tension was moderate. The flap was trimmed, the incision was sutured, the plasma tube was placed, the wound was sutured layer by layer, the wound was sterilized, the sterile dressing was pressurized, and the tourniquet was loosened. The patient was satisfied with anesthesia during the operation, and the operation was smooth. About 20ml was produced during the operation, and the breathing was strong after anesthesia and the vital signs were stable.

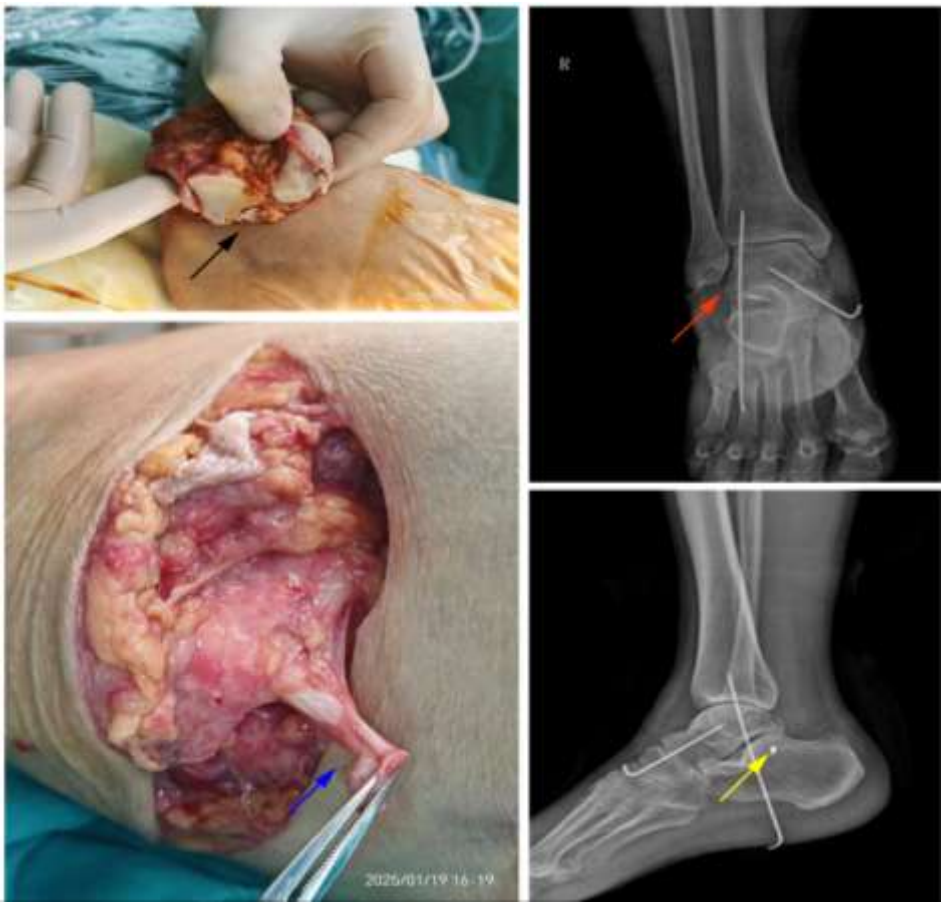

Figure 2 Intraoperative conditions: ankle dislocation with severe cartilage injury (black arrow),

broken stumps of the calcaneofibular ligament (blue arrow), two Kirschner wires penetrating the calcaneus, talus and tibia on the lateral side and the talus and scaphoid on the medial side, stabilization of the talocalcaneal joint and talonavicular joint (red arrow), and metal band anchor for reconstruction of the calcaneofibular ligament (yellow arrow).

During the perioperative period, sensitive antibiotics were used to prevent or control infection according to the results of broad-spectrum or drug sensitivity of bacterial culture of wound secretion. The affected limb was elevated by using an orthopedic bed, and the drainage tube was removed when the drainage volume was less than 20ml/d. The drainage tube was removed when the drainage volume was less than 20 ml/d. The muscle contraction exercise of the affected limb was performed on the second day after operation. After 4 weeks of removal of Kirschner wire fixation of the tibial talar joint, appropriate ankle extension, flexion, internal and external rotation functional exercise combined with passive and active, and walking exercise without weight bearing under the protection of double crutches were performed. Light weight-bearing exercise was started at 6 weeks. At 8 weeks, weight-bearing walking was abandoned and functional exercise was strengthened. X-ray films were taken every 1-2 months to observe the fracture alignment and healing. (See Figure 3).

FIG. 3 Postoperative X-ray films showed that the internal fixation was in place, no failure of the internal fixation was observed, and the ankle joint returned to normal physiological structure and function

2 Discussion

Opening ankle fracture with dislocation is more common in high-energy injuries such as traffic accident and falling from height. It is often combined with other organ injuries. The operation time is urgent, and the general condition and the requirements of anesthesia make the operation time not as long as conventional surgery, especially in primary hospitals[1] . Improper debridement in the early stage of Gustilo type III ankle fracture with dislocation is prone to infection, tissue necrosis, bone exposure, malunion and traumatic arthritis. Combined injury

should be treated with debridement and fracture fixation[2] in early stage when vital signs are stable. Ankle fracture with dislocation belongs to intra-articular fracture. In order to obtain ideal ankle function and reduce the occurrence of postoperative complications, the operation must achieve anatomical reduction of the joint[3] and stable ankle joint.

Wound management: repeated irrigation and thorough debridement with large amount of normal saline, hydrogen peroxide, and iodophor, strict implementation of aseptic standards, early application of effective antibiotics, and adequate drainage tube were the main factors for no deep infection after operation in this case. The thin subcutaneous tissue of the foot and ankle is prone to subcutaneous hemorrhage and skin necrosis after trauma. The following measures were used to protect the vitality of the skin: ① The increase of wound tension and skin ischemic necrosis caused by reactive hyperemia and hypoxia and swelling were reduced as much as possible during the operation; ② The contusion skin should be kept as much as possible to close the wound, even if partial necrosis occurred after the second stage debridement; ③ When the wound needs to be expanded, the incision should be extended along the arc of the original wound as far as possible to avoid skin necrosis at the intersection of the incision and the wound. [4] ④ Peel the skin, fascia, and periosteum as much as possible to expose the fracture end, so as to preserve skin blood supply to the maximum extent. ⑤ For patients with craniocerebral and thoracoabdominal injuries who cannot be treated with fracture internal fixation in emergency, Kirschner wire is used to temporarily fix and close the wound after debridement, which can prevent wound skin contracture and skin necrosis caused by fracture displacement and compression, and is conducive to the second stage operation. ⑥ For suture wounds with large skin tension, using a sharp knife to poke multiple holes to decompress is beneficial to detumescence and wound healing. In this case, the wound was thoroughly debridement, necrotic tissue and skin margin were removed within 6 hours after injury, and primary suture and indwelling drainage tube were performed, which reduced infection and promoted local soft tissue healing without skin tissue necrosis.

In the traditional treatment, the external fixator fixes the ankle joint in the normal anatomical position and takes into account the treatment of soft tissue injury, which can reduce the incidence of soft tissue infection, is conducive to the observation of the wound condition, and is helpful for the later treatment and prevention of some complications[5] . The stability of soft tissue is very important for opening ankle fractures. Once treated properly, it is easy to cause scar contracture, Achilles tendon contracture, secondary equinus foot, etc. After the application of external fixator, the affected limb can move early, reduce tissue edema, stabilize soft tissue, and promote wound healing. Most opening ankle fractures can be healed by themselves after postoperative dressing change, and some patients need to be repaired with flaps for wound formation. The external fixator does not affect the operation of the flap and is conducive to preoperative and postoperative wound care. The external fixator protects the ankle joint from always being in the functional position, and the ankle joint deformity will not affect the function due to soft tissue problems. However, there is a high risk of pin tract infection of external fixator: the fixation nail needs to pass through the skin, which destroys the integrity of the skin. It is easy for external bacteria to enter the body through the pin tract and cause infection. After infection, there will be local symptoms such as redness, pain, and exudation. In severe cases, it may lead to osteomyelitis, which will affect the healing of fracture and increase the pain and difficulty of treatment for patients. During the process of use, the fixation needle may become loose or broken. This may be caused by improper movement of the patient, weak fixation between the fixation needle and the bone, and other reasons. Loosening or breakage of the fixation needle will affect the stability of the external fixator, and then affect the reduction and fixation effect of the fracture, which may lead to fracture displacement, malunion and other complications. The external fixation device occupies a certain space, which may cause friction or collision with the surrounding muscles, tendons and other tissues, resulting in reduced range of motion of the joint. Long-term joint movement limitation may also cause joint stiffness, muscle atrophy and other problems, which may affect the functional recovery of the limb. The external fixator is usually conspicuous, which will affect the appearance of the patient and bring

psychological pressure to the patient. At the same time, external fixators may bring a lot of inconvenience in daily life, such as easy to touch objects, resulting in pain, affecting walking, sitting and lying, etc. Generally, it takes a long time to remove the external fixator, and patients need to endure the discomfort and inconvenience caused by external fixation for a long time, and they need to go to the hospital regularly for review and adjustment of the external fix[6] ator during the treatment.

Ankle fractures are intra-articular fractures, and the quality of reduction determines the quality of functional recovery. During the operation, it is necessary to completely remove the soft tissue between the fracture ends, remove the small free bone fragments and articular cartilage in the joint cavity, repair the injured articular cartilage, and retain the bone fragments with the large articular cartilage surface, and use Kirschner wire after reduction. Special attention should be paid to the Kirschner wire fixation in the "[7] safe zone" to avoid affecting the postoperative ankle function. Restore the anatomical relationship of ankle points, maintain the normal physiological slope and articular surface of the medial and lateral malleolus, so as to adapt to the anatomical morphology of the talus with narrow posterior upper and wide anterior lower, and try to avoid or reduce the occurrence of traumatic arthritis. The lateral malleolus is the key to the treatment of ankle joint injury. Experiments and clinical studies have shown that the talus is displaced closely after the lateral malleolus, that is, the lateral malleolus is displaced to the outside, and the talus is also displaced. If the lateral malleolus can be anatomically reduced, the talus will also be anatomically reduced[8] . The reduction sequence should be selected according to the different injury mechanism. Pronation-external rotation, pronation-abduction, and supination external rotation fractures are all displaced and unstable to the lateral side. The reduction follows the reduction sequence of lateral malleolus - distal tibiofibular joint or posterior malleolus - talus and medial malleolus. Supination-adduction fractures are medially displaced and unstable, and the reduction follows the reduction sequence of medial malleolus, talus, and lateral malleolus. In the special case of severe comminuted fracture of the lateral malleolus, it is very difficult to perform the precise reduction of the lateral malleolus fracture first. After the tibiotalar joint dislocation is repaired, the medial malleolus can be reduced and fixed first, so that the talus can be returned to the ankle point, and then the lateral articular surface of the talus can be used as a guide for reduction and fixation of the lateral malleolus, which can achieve twice the effect with half the work. It is generally believed that when the posterior malleolus fracture involves more than 25% of the articular surface of the distal tibia and the displacement is more than 2mm, opening reduction and internal fixation are required. The posterior or posterolateral incision should be used according to the position of the posterior malleolus fracture fragment. For the posterior malleolar fracture caused by the medial malleolar wound in the distal tibia, the distal tibial extrusion method can be used to reduce and fix the posterior malleolus under direct vision and shorten the operation time[9] . In this case, the author reduced the talocalcaneal joint and talonavicular joint after thorough debridement, and used two 2.0 Kirschner wires to enter from the medial and lateral edge of the sole, penetrate the calcaneus, talus and tibia on the lateral side, and penetrate the talus and scaphoid on the medial side to fix the talonavicular joint and talonavicular joint, instead of the suture repair of the periankle ligament. The Kirschner wire was removed 4 weeks after operation. The Kirschner wire was removed at 4 weeks after operation. The stability of the injured and broken ligament was reconstructed through scar adhesion and healing, and the follow-up effect was good.

The quality of reduction and fixation and the repair result of soft tissue injury after ankle fracture and dislocation directly affect the function and stability of the ankle joint after operation. The repair of ligaments, especially deltoid ligament, in opening ankle fractures is still controversial. The study showed that 50 ankle fracture patients with deltoid ligament rupture were randomly divided into deltoid ligament repair group and non-deltoid ligament repair group. The results showed that the operation time of the suture group was longer, but there was no significant difference in pain and function at follow-up between the two groups, suggesting that even if the deltoid ligament is not repaired, the function[10] of the affected limb is not affected. Meta-analysis of the effects of repair and non-repair of the deltoid ligament in ankle fracture

combined with deltoid ligament injury showed that repair of the deltoid ligament had better postoperative functional effect, higher Mazur score, and fewer complications such as ankle stiffness than non-repair of the deltoid ligament. In view of this, the author used a metal belt anchor to reconstruct the rupture zone of the calcaneofibular ligament during the operation to strengthen the stability of the ankle joint and promote its healing.

In this case, percutaneous minimally invasive internal fixation and metal band anchor were used to treat Gustilo type III opening ankle fracture with dislocation. Not only the operation time was significantly shortened, but also excellent clinical efficacy was obtained. 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.

Opening ankle fracture with dislocation has always been a difficult problem for orthopedic surgeons due to its complex anatomical structure and injury mechanism. In order to achieve exact and effective reduction and fixation, and restore the anatomical structure of the ankle joint as much as possible, the removal of external fixation surgery is generally the main treatment plan. In the future, the diagnosis and treatment of opening ankle fracture with dislocation, the repair and fixation of soft tissue and fracture fragments, especially whether the ankle ligaments should be routinely repaired and reconstructed need to be further explored. The choice of surgical approach and the protection of flaps need to be further improved. There are many postoperative complications of opening ankle fracture with dislocation, and the prevention and treatment of functional recovery exercises and complications need to be further improved.

In conclusion, clinicians should take comprehensive consideration and propose personalized treatment for patients with opening ankle fracture and dislocation. 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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