

Discussion on Calcaneal Fracture and Its Classification and Treatment

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Abstract: Calcaneal fracture is the most common tarsal fracture of the foot, which is mostly caused by violence. At present, the most popular classification methods are Sanders classification and Exes-Lopsti classification. Sanders classification is often used to judge the treatment and prognosis of calcaneal fractures. The earliest widely accepted classification is Exes-Lopsti classification. For different types of calcaneal fractures, we can choose a variety of treatment methods, such as non-operative treatment, open reduction and internal fixation, round needle reduction and stabilization and so on. Clinically, the appropriate treatment should be selected according to the degree of injury, classification and physical condition of the patients.

Keywords: Calcaneal Fracture; Classification; Treatment

1. Anatomical characteristics of calcaneus and its related tissues

The three-point weight-bearing surface composed of the first metatarsal head, the fifth metatarsal head and the calcaneus constitutes the main weight-bearing structure of the normal foot. Calcaneus, as the largest of the seven tarsal bones of the foot, is an irregular dice-shaped bone with 6 surfaces and 4 articular surfaces, which is composed of a large amount of cancellous bone and a shallow layer of bone cortex. There is an important joint between calcaneus and talus, called subtalar joint, which is a very stable joint. The joint can make the foot valgus, abduction or adduction, valgus, so that the foot can adapt to the uneven terrain. An important sign of subtalar joint connection is the joint angle of calcaneal tubercle. The joint angle of calcaneal tubercle is the angle between the upper edge of calcaneal tubercle and the articular surface of calcaneus. Also known as Bohler angle.

2. Common causes of calcaneal fracture

Indirect violence, especially conveying violence, is a common cause of calcaneal fractures. Injuries are often caused by falling or squeezing from a height. Because the gravity of the human body is concentrated from the talus to the calcaneus, the reverse force on the ground is uploaded to the body of the calcaneus. If the reaction force exceeds the load-bearing range of the calcaneal body, the calcaneus will be compressed or even cracked. There are also a small number of traction fractures caused by traction of the Achilles tendon.

3. Main points of diagnosis and examination of calcaneal fracture

The posterior arm of the longitudinal arch of the foot collapses after the calcaneal fracture, and the joint angle of the calcaneal tubercle changes accordingly. The common changes are that the joint angle of calcaneal tubercle decreases, disappears and even becomes negative. Thus affecting the elasticity of the posterior arm of the longitudinal arch and weakening the metatarsal flexion. Because most of the calcaneus is cancellous, there are few nonunion after injury, and the transverse diameter of the heel is often widened due to stress damage, and the arch is flattened in severe cases. The clinical manifestations of the patients after injury were calcaneal pain, limited movement, audible bone friction and bone friction sensation. At the same time, the fracture is accompanied by congestion, deformity, tenderness and swelling. The type of calcaneal fracture and the degree of injury can often be determined according to the positive and lateral X-ray film and axial film. At the same time, because

the transmission of violence of the calcaneus can also cause spinal compression fracture, and even the force is uploaded with the spine, causing head and skull injury, ^[1] so the clinical diagnosis of calcaneal fracture should also ask and check the condition of the patient's brain and spine.

4. Classification of calcaneal fracture

There are many types of calcaneal fractures, and the most popular classification is Sanders classification based on coronal CT and three-dimensional reconstruction of calcaneus ^[2]. At the same time, the Exes-Lopsti classification is judged by X-ray. Among them, Sanders' method selects the widest transverse diameter of the calcaneal articular surface, focusing on the injury of the posterior articular surface of the calcaneus. The posterior articular surface of the calcaneus is divided into three equal widths with two lines, and the calcaneus is divided into four parts with talus. Sanders type I has no bone fragments on the posterior articular surface and has one or more fracture lines with a transverse diameter of less than 2 mm. Good clinical results can be obtained by closed reduction and fixation. Saunders type II refers to 2 fractures in which the posterior articular surface is divided into two parts. And the displacement of the fracture line was more than 2 mm. According to the position of the fracture line from the outside to the inside, Sanders type II was divided into three types: II A, II B and II C. Sanders type III means that the posterior articular surface is divided into three parts by two fracture lines, and can be divided into type III AB, type III AC and type III BC according to the location of the main fracture lines. Sanders type III often uses open reduction and internal fixation. Because the injury of the patients is complicated, the prognosis is often poor. Sanders type IV fracture refers to a highly comminuted fracture with more than four fragments. Most bone and injury doctors think that Sanders classification ^[3] can better show the degree of injury of the posterior articular surface compared with Excelotti's classification. It has more accurate clinical guiding significance for selecting treatment methods and judging the rehabilitation effect of calcaneal fracture. Therefore, this method is more widely used in clinic.

Although Exes-Lopsti classification has many disadvantages nowadays, it is the first widely accepted classification of calcaneal fracture proposed in 1952. According to the lateral and axial position of calcaneal X-ray, calcaneal fractures are divided into two types: tongue-shaped calcaneal fractures and joint collapse calcaneal fractures, and they are divided into three degrees according to the degree of displacement of fracture fragments. Exes-Lopsti classification can be used to evaluate the displacement of calcaneal fractures. Exes-Lopsti classification type I means that the fracture does not affect the calcaneal joint, the impact on the patient is smaller than the latter, and the prognosis is good. Most of them include calcaneocuboid joint fractures and calcaneal tubercle fractures. Exes-Lopsti type II refers to the involvement of the subtalar joint. And most of the fracture lines pass through the medial part or the posterior part. Among them, tongue fracture and articular surface collapse fracture are divided according to the shape of secondary fracture line, and because of the different degree of injury, the two types of fractures are divided into three subtypes: I degree, II degree and III degree. Exes-Lopsti classification type II tongue fracture three subtypes all refer to the distal side of the secondary fracture line extending back horizontally to the stop point of the Achilles tendon. The hyoid bone fragments formed as a result of injury include the upper part of the calcaneal body and the lateral part of the posterior articular surface. Exes-Lopsti classification type II type I tongue fracture refers to the violence through the calcaneal joint to produce the original fracture line, in the X-ray film can only see the fracture crack, no separation, insertion and displacement. Exes-Lopsti classification type II second-degree tongue fracture refers to the secondary fracture line extending to the posterior edge of the calcaneal tubercle with no obvious displacement. Exes-Lopsti classification type II type III tongue fracture means that the back end of the bone piece is upward, and the front end of the bone piece is embedded downward into the cancellous bone of the calcaneus, showing the separation and displacement of each fracture piece. Excelotti's type II collapse fracture refers to the secondary fracture line passing through the calcaneal body to the posterior articular surface and the attachment point of the Achilles tendon. Among them, Exes-Lopsti classification type II type I collapse fracture means that the secondary fracture line passes through the calcaneal body to the back of the joint, and the displacement of the fracture block is not obvious. Exes-Lopsti classification type II type II collapsing fracture refers to the displacement of the fracture piece of the articular surface and falling into the cancellous bone of the calcaneal body. Exes-Lopsti classification type II third degree collapse fracture refers to the separation and displacement of the fracture block.

However, the Exes-Lopsti classification ^[4] is based on X-ray, so it can not reflect the details of posterior articular surface injury according to displaced and comminuted fractures. According to the clinical treatment and research of calcaneal fracture, the injury of posterior articular surface of

calcaneus is very important for the reduction and prognosis of calcaneal fracture. Therefore, there are still some shortcomings in the Exes-Lopsti classification.

5. Treatment of calcaneal fracture

The key to foot function is to restore the normal anatomical relationship of calcaneal fracture, so that the injury of subtalar joint can be healed well. At the same time, the emergence of a variety of treatment methods, such as manual reduction, functional exercise, physiotherapy, open reduction and internal fixation, bone needle pry reduction and fixation, joint fusion and so on, provide a more appropriate treatment for the continuous improvement of clinical efficacy.

5.1 Non-operative treatment of calcaneal fracture

Non-operative treatment of calcaneal fracture is mainly through traditional Chinese medicine manual reduction and manual reduction combined with plaster or small splint external fixation, functional exercise and traditional Chinese medicine physiotherapy and other methods for calcaneal fracture displacement is not obvious or soft tissue condition is not suitable for surgical treatment. Non-operative treatment can protect the integrity of periosteum as completely as possible, so as to avoid the prolongation of fracture healing period, relieve patients' swelling and pain symptoms as soon as possible, and enable 3 patients to enter functional exercise in the early stage. improve the prognosis of calcaneal fracture. Trauma orthopaedic expert you Shaoyu ^[5] has pointed out that the indications for non-operative treatment of calcaneal fracture are as follows: 1 if the displacement of the fracture does not exceed 1mm or there is no displacement, non-operative treatment can be considered. 2)the severe comminuted fracture which can not restore the normal shape of the talocalcaneal articular surface can be treated by non-operation. 3 patients with diseases such as cardio-cerebrovascular diseases due to soft tissue and physical conditions, or mental will can not be treated by operation can be treated by non-operation. 4 the fracture of subtalar joint in children can also be treated by non-operation because the epiphysis is not fully developed.

5.1.1 Calcaneal fracture with no injury to the articular surface of calcaneus

For fractures that occur in the calcaneal tubercle, a small longitudinal displacement can be given to end lifting and pressing to restore the normal anatomical relationship. On the other hand, it occurs in the calcaneal tubercle with upward displacement and large volume, which is a kind of avulsion fracture. Under local anesthesia with lidocaine, the patient can be told to lie prone, bend the knee and bend the foot as far as possible. For those with limited movement, the assistant can passively bend the patient's foot, and the doctor can push the avulsed fracture piece on both sides of the Achilles tendon to restore the anatomical structure.

If the articular surface of the inferior talus is not affected, the calcaneal tubercle moves backward and upward with the posterior half of the calcaneal body. Patients should be advised to take supine position and flexion of knee joint at right angle. The assistant holds the lower leg of the patient with both hands and uses the force backward horizontally, and the operator's fingers cross each other, and the palm drags the heel to correct the patient's lateral displacement, while countering the assistant's horizontal traction to restore the normal joint angle of tubercle of calcaneus (Bohler angle).

5.1.2 Calcaneal fracture with injury to the articular surface of calcaneus

For the patients with more and obvious displacement, articular surface collapse and comminuted fracture, the widened calcaneal body should be corrected as far as possible, and the joint angle of calcaneal tubercle should be restored as far as possible. The operator can squeeze the heel gently and steadily with the palm of the hand, shake the heel and push down to correct the nodular joint angle as much as possible.

5.2 Surgical treatment of calcaneal fracture

For the displaced calcaneal fracture, the effect of surgical treatment is particularly significant. The surgical treatment of calcaneal fracture includes open reduction and internal fixation, bone round needle pry reduction and fixation, joint fusion and external fixation and so on. At the same time, in order to reduce the postoperative soft tissue complications of calcaneal fracture, surgical treatment can be performed within 1-2 weeks after fracture injury ^[6].

5.2.1 Open reduction and internal fixation

In clinic, if the displacement of posterior articular surface fracture exceeds 2mm, surgical reduction is needed. It is commonly used in Sanders type II and Sanders type III calcaneal fractures. The indications are as follows^[7]: 1 intra-articular fracture of calcaneus with obvious displacement, 2 extraarticular fracture of calcaneus with severe collapse, widening and shortening of calcaneus. The timing of surgical treatment is generally no more than 2 weeks after injury. Otherwise, scar adhesion occurs around the fracture, which increases the difficulty of reduction^[8], resulting in a poor prognosis. At the same time, the probability of infection increases with the extension of time after injury.

The main purpose of the operation is to restore the shape of the calcaneus and the weight-bearing capacity of the calcaneus. At the same time, the flatness of the talocalcaneal articular surface and the nodular joint angle should be restored. During the operation, repeated operation should be avoided as far as possible to maintain the integrity of cancellous bone.

5.2.2 Bone round needle pry reduction and fixation

Compared with open reduction and internal fixation, the use of bone circle for pry reduction of fracture site is more convenient, less complications and better clinical effect.

For example, for a compression collapse in the middle of the calcaneus, the round needle can be pierced below the collapse, tilted up to maintain its position, and then the talus and calcaneal fracture pieces are penetrated and fixed. If the posterior lower part of the calcaneus is fractured and displaced, the longitudinal axis of the calcaneus can be extended to pry up the displaced fracture block to maintain its position and fixed through the anterior part of the calcaneus.

After operation, the steel needle was removed after external fixation with plaster for 4-5 weeks, and the weight-bearing walking began after 8-10 weeks^[9].

5.2.3 Calcaneal tubercle traction [10]

If the epiphysis of the calcaneal tubercle is separated and the fracture piece is moved upward, or the coronal fracture of the calcaneal body, and the posterior end fracture piece moves upward, it is suitable for calcaneal tubercle traction. The puncture point is above the posterior part of the calcaneal tubercle, and it can be passed through the puncture point with a round needle in the aseptic operating room, and can be pulled downward and backward in the opposite direction of the displacement of the fracture block. Restore the dislocated fracture block to normal anatomical structure and restore the normal position of the lower part of the calcaneal tubercle joint. The time of traction is suitable for 3-4 weeks, and functional exercise should be carried out as soon as possible after removing the traction needle.

6. Postoperative nursing care of calcaneal fracture

The joint angle and Gissane angle of calcaneal tubercle should be re-measured after operation to evaluate the operation and prognosis. The normal joint angle of calcaneal tubercle under X-ray is 30-40 degrees. The normal angle of Gissane is 120-145 degrees. After the fracture block is reduced to the normal position and fixed, the patient should be advised to move the toe independently, and the lower limb movement should be gradually increased after removal and fixation. If the patient is injured to the talocalcaneal joint, excessive foot dorsal extension should not be carried out in the early stage after external fixation is removed. And in the later stage of exercise, there should be no severe pain and abnormal discomfort.

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