Simultaneous Surgical Treatment of Sternum and Costal Cartilage Fractures

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Studies have confirmed that, for severe flail chest or sternal fractures and even multiple rib fractures, surgical treatment can effectively reduce hospital stay and relieve chest wall pain. However, fixation of multiple costal cartilage fractures in such a small area is a challenge if an internal fixator is simply placed directly on the sternum. This case report shares a method of simultaneous fixation of multiple costal cartilage and sternal fractures through a small incision, and it is also appropriate for multiple costal cartilage fractures without sternal fracture.

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Operation is the main treatment for flail chest, sternum fracture, and multiple rib fractures, but as for costal cartilage fractures, conservative therapy has been more common until recently. Because metal plates and screws are unsuitable for cartilage, surgical treatment has not been used for costal cartilage injuries. This case report shares a method that not only solves the problem of fixation of costal cartilage fractures, but also permits simultaneous fixation of multiple costal cartilage and sternal fractures through a small incision.

A 52-year-old man with dyspnea and chest pain after injury for 12 hours presented to the emergency department. The patient had been injured by about 100 tons of weight on a construction site, and he had severe chest pain and difficulty in breathing. After hemostatic therapy, pain relief, chest strap fixation, and tracheal intubation in another hospital, he was transferred to our hospital for further treatment.

He had no history of hypertension, diabetes, or epilepsy, and he had been healthy before the accident. Physical examination revealed oral endotracheal intubation, shortness of breath, paradoxical breathing movement of anterior chest wall, chest deformity, crepitus in the anterior chest wall and neck, subcutaneous emphysema, purple skin in the chest wall, bilateral anterior chest wall tenderness, and motor and sensory disturbances below the umbilical level.

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Emergency chest roentgenograms showed fractures of the T11 vertebral body and the T10 spinous process, and T10 anterior spondylolisthesis led to spinal compression. A computed tomographic chest scan revealed fractures of bilateral ribs, costal cartilages, and sternum, combined with bilateral hemopneumothorax, lung contusion, and slight accumulation of gas in the mediastinum and chest wall (Figs 1A, 1B). Other investigations, including hemogram, urine examination, and renal parameters, indicated that his hemoglobin concentration was 75 g/L, urea concentration was 29.6 mmol/L, creatinine concentration was 386 μmol/L, and uric acid concentration was 662 μmol/L.

We made a preliminary diagnosis of bilateral multiple rib fractures, sternum fractures, thoracolumbar fractures, paraplegia, bilateral pneumothorax, pulmonary contusion, rhabdomyolysis syndrome, acute respiratory distress syndrome, multiple organ dysfunction syndrome, and acute renal failure. After admission, while waiting for an optimal time for operation, the patient underwent electrocardiographic monitoring, chest and abdominal band fixation, ventilator-assisted respiration, closed thoracic drainage, antiinfective therapy, nutritional support, blood transfusion, and regular hemodialysis. The patient underwent tracheotomy and mechanical ventilation 20 days after admission because of his chest wall softening and abnormal breathing, which required mechanical ventilation for an extended period.

Using an anterior median incision, we separated the peripheral tissues to expose the bilateral costal cartilages with ease. A comminuted fracture with obvious interruption at the angle of the sternum was found. Some cortices of the broken ends were angulated and impacted. Bilateral costal cartilages 2 to 5 were also fractured, which caused the anterior chest wall to become obviously softened and deformed. After exposing the fractured ends of the sternum by detaching the surrounding muscles and periosteum, we fixed the sternal fracture with two parallel titanium plates placed in the middle of the sternum to create a site for rib fixation. Then we exposed the bilateral costal cartilaginous ends similarly. After the reduction was satisfied and the titanium plates were properly shaped, we fixed the distal parts of the plates to the ribs with locking screws, but the proximal ends of plates were fixed to the sternum. Then the unstable fragments of the costal cartilage fractures were fixed to plates by suture (Fig 1C). Finally, the reduction was satisfactory, and the anterior chest wall was stable. Then we placed a negative-pressure drainage system and a chest tube and closed the incision layer by layer after careful hemostasis. After the operation, mechanical auxiliary ventilation was continued. The chest tube was removed 8 days after the operation. At that time, a roentgenogram showed that the internal fixation and chest wall were stable, and the patient's abnormal respiration had disappeared (Fig 1D). A gradual trial of spontaneous breathing was conducted on the 40th day after the operation, and on the 43rd

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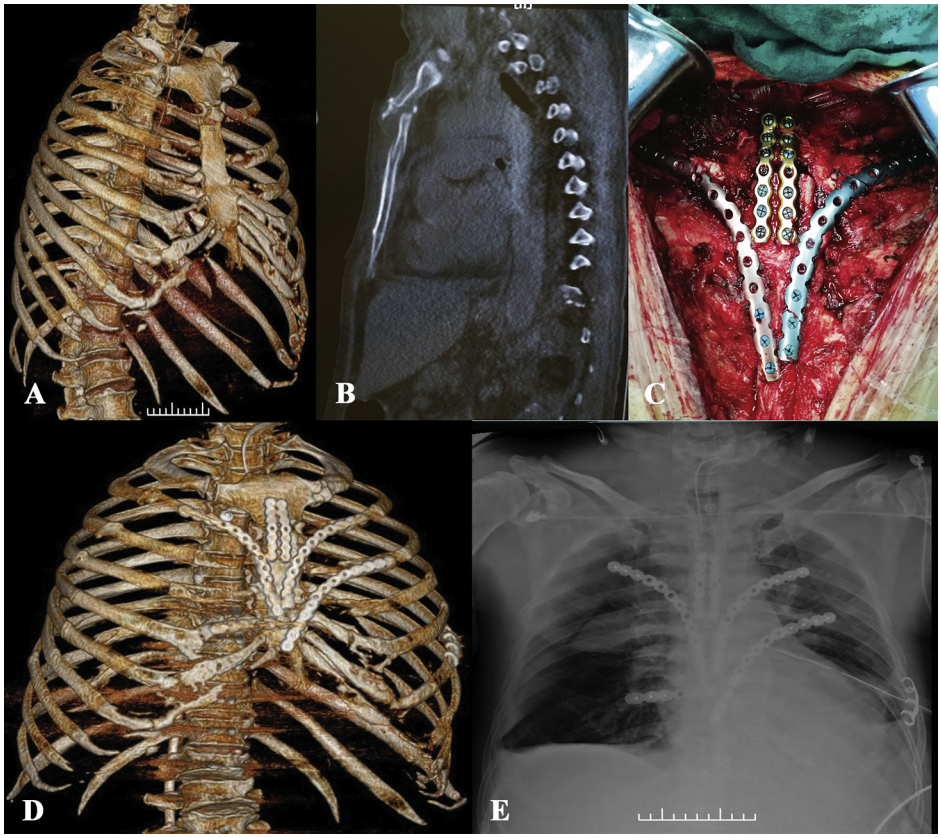

Fig 1. (A) Computed tomographic (CT) three-dimensional reconstruction image of the chest wall on admission. (B) CT image of the sternum. (C) Surgical procedure: fixation of sternal and multiple costal cartilage fractures. (D) CT three-dimensional reconstruction image of the chest wall after operation. (E) Chest film obtained 4 days after operation.

postoperative day, posterior decompression and internal fixation of the thoracic vertebrae were performed successfully with the patient in the prone position.

Comment

The study confirms that whether it is a severe flail chest, a sternum fracture, or even multiple rib fractures, surgical treatment can effectively reduce the hospital stay and the duration of intensive care unit stay [1, 2]. In addition, the curative effect in a patient with pulmonary infection and thoracic deformity is obvious. In our case, the patient had a severe floating chest wall deformity and was not able to be weaned from the ventilator before the operation. At that time, he was unable to undergo decompression and internal fixation of the thoracic vertebrae, although these procedures were performed later. Surgical intervention is unavoidable for comminuted fractures of the sternum and bilateral costal cartilages, but fixation of so many fractures in such a small area is a challenge.

Because the patient's abnormal respiration was mainly concentrated on the anterior chest wall, and he had a fracture of the thoracic vertebra as well as renal failure, it was necessary to shorten the operation time. We therefore decided to fix the anterior chest wall instead of all the fractured ribs by using a single median approach. As it turned out, this was the best surgical procedure for sternum and costal cartilage fixation in patient, especially because fixation with titanium plates and screws is not reliable for costal cartilage fractures [3].

In this case, the bilateral ribs and the sternum were fixed together with arc-shaped plates. The fractured costal cartilages were then sutured onto the plates (Fig 1C). Studies show that there is no effective treatment for costal cartilage fractures. Through this case we discovered that this method applies not only to multiple fractures of costal cartilages, but also to multiple fractures of costal cartilages and the sternum (Figs 1D, 1E). Therefore, it is worth recommending this method in clinical practice.

References

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