Current Situation of Surgical Treatment for Rib Fractures in China: Questionnaires from Multi-hospital

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Abstract

Background: Although chest wall stabilization (CWS) has been widely performed for rib fractures in the past decade in China, consensus about operative indication, timing, and technical details for CWS is not formulated yet. The aim of this study is to investigate the existing situation of surgical treatment for rib fractures in China.

Methods: Four hundred and fourteen questionnaires were sent out to surgeons in different hospitals in China and collected between January 2018 and April 2018. Data were reviewed and extracted for analysis.

Results: Three-hundred and seventy-one valid questionnaires were included in this study. About 14500 cases of CWS for rib fracture were performed in the investigated hospitals in 2016 and about 17600 cases in 2017. There were 38.3% hospitals performed chest wall stabilization for single rib fracture and 44.9% hospitals performed chest wall stabilization for two rib fractures. About 92.1% of CWS cases were performed within two weeks while 42.2% surgeons performed CWS for patients with rib fracture more than two weeks. CWS was performed in 95.6% of hospitals and 93.2% cases were performed by thoracic surgeons. Nickel-titanium memory alloy and pure titanium rib embracing device are mostly used in rib fixation. Only 33.93% of surgeons chose to remove internal fixator at one year after surgery.

Conclusions: Although CWS has been widely performed in China, there are many controversies on the indications, timing, and technical details of CWS. Large-scale clinical trial, high-level literature, uniform standards of surgical indications are critical for the healthy development of CWS.

Introduction

Rib fracture is a common disease in thoracic surgery, accounting for about 60–70% of admissions for thoracic trauma. Rib fractures predominantly locate in the fourth to ninth ribs [1]. Acute lung injury and flail chest and even acute respiratory failure are the most common complications of multiple rib fractures. Some serious cases can even directly threaten lives, especially in patients with multiple injuries. The number of fractured ribs was associated with rate of mortality and morbidity and patients with isolated rib fractures more than two ribs were suggested to be hospitalized [2].

Previous studies compared the efficacy of conservative treatment and surgical treatment for flail chest [3–5]. The results showed that surgical fixation reduced the incidence of pneumonia and significantly shortened the duration of mechanical ventilation, the length of ICU stay and overall hospital stay. However, there is still no consensus on the operative indication for rib fractures without flail chest. Thomas W. White and colleagues believed patients with 3 or more rib fractures with displacement or invalid conservative treatment also should be treated with chest wall fixation [6]. However, no RCT was performed to compare the efficacy between the two treatments for patients with non-flail chest rib fractures.

China has the largest population in the world. About 200 million injuries and more than 700 thousand deaths were reported in the mainland of China annually, accounting for 9% of the mortalities, ranking No. 5 among the cause of death [7]. Chest wall trauma is an important part of injury in China while rib fracture is the most common type, which is scarcely reported. Here we performed an investigation to explore the existing situation of surgical treatment for rib fracture in China.

Method

From January 2018 to April 2018, 414 questionnaires were sent out to 414 surgeons from multiple hospitals in China. The inclusion criteria were: 1) all surgeons were from hospitals qualified to treat patients with thoracic trauma; 2) all surgeons had experience in dealing with thoracic trauma; 3) all surgeons come from different hospitals. Exclusion: 1) questionnaires with incomplete information; 2) questionnaires with error message (such as logic errors in the answers). All surgeons were asked to complete the questionnaire and send back to authors by email or WeChat or mail. The questionnaire included general information of the surgeons (such as age, title, medical specialty, hospital name and so on) and a series of questions about their assessment and treatment on rib fractures (including single-choice questions and multiple-choice questions). The questionnaire was drafted by a team of more than ten experience thoracic surgeons. Data were reviewed and extracted from questionnaires for analysis. The algorithm for patient selection is shown in Fig. 1.

Results

The questionnaires covered all provinces of mainland China, Hong Kong and Taiwan district. All surgeons were asked to complete a questionnaire and send it to the authors of this study. After carefully reviewed the collected questionnaires, 43 questionnaires were excluded from this study due to incomplete or incorrect data.

Among them, 86.7% surgeons were from teaching hospitals, 69.2% from grade III-A hospitals, 15.3% from grade III-B hospitals, 14.8% from grade II-A hospitals and 0.7% from grade II-B hospitals (Fig. 2). Among these hospitals, 93.2% cases of rib fractures were treated by thoracic surgeons, 1.9% cases were treated by trauma surgeons, 1.7% cases were treated by orthopedics, 0.50% cases were treated by emergency surgeons and 2.7% cases were treated by other surgeons (Fig. 3). Among these surgeons, 95.63% of them had performed CWS for rib fractures. Among the surgeons who had performed CWS, 5.58% were residents, 38.35% were attending doctors, 32.77% were associate chief physicians, and 23.3% were chief physicians (Fig. 4).

There were about 14500 cases of CWS were performed in the investigated hospitals in 2016 and about 17600 cases in 2017 (Fig. 5). Most surgeons believed that rib fixation can improve respiratory function, relieve pain, reduce pulmonary complications, promote early recovery, shorten treatment period (including length of hospital stay, length of intensive care unit stay, mechanical ventilation time, etc.) and restore thoracic contour when compared with conservative treatment (Fig. 6). Most surgeons suggested CWS

should be performed for patients who have three or more displaced rib fractures, or flail chest, or patients with rib fractures needing thoracic surgeries for other reasons, or patients with chest wall deformity, or patients with severe pain cannot be relieved by conservative treatment (Fig. 7). However, our survey also showed that 38.3% surgeons had performed CWS for single rib fracture and 44.9% surgeons had performed CWS for two rib fractures. When patients with multiple rib fractures combined with other parts of trauma (such as spine, pelvis, abdomen and brain), 82.23% surgeons believed CWS should be performed if patients were in stable condition.

Although 92.1% of CWS cases were performed within two weeks, there were still 42.2% surgeons had performed CWS for patients with rib fracture more than two weeks. Severe chest pain with poor drug treatment effect, obvious deformity of chest and chronic nonunion of fracture were the major reasons for above situation (Fig. 8).

Most surgeons had performed CWS for 3th to 10th rib fractures, 19.0% surgeons had performed CWS for 1th and/or 2th rib fractures, 30.0% surgeons had performed CWS for 11th and/or 12th rib fractures, 37.56% surgeons had performed CWS for costal cartilage fractures, 41.62% surgeons had performed CWS for paraspinal rib fractures and 17.51% surgeons had performed CWS for dislocation of sternoclavicular joint (Fig. 9). Nickel-titanium memory alloy and pure titanium rib embracing device are mostly used in rib fixation. Only 33.93% of surgeons chose to remove internal fixator at one year after surgery. The major reasons for removing internal fixator were: patients' requirements, patients have symptoms of discomfort, doctors' advice (Fig. 10). Although most surgeons in this study had performed CWS for rib fracture, the rate of surgical treatment for multiple rib fractures is still very low. The main factors restricting the development of CWS are as follows: lacking of strong literature support, lacking of evidence from large-scale RCT studies, lacking of effective internal fixation materials, lacking of relevant technical experience, high operation related costs (including internal fixation materials), lacking of attention and support from relevant academic organizations and activities, lacking of support from of hospital management department or other departments (Fig. 11).

Discussion

Chest wall trauma is common in the world, and rib fracture is the most common type [6]. Surgical stabilization of rib fractures showed better outcomes when compared with conservative treatment in patients with flail chest, which had aroused great interest in thoracic surgeons [3–5]. Although CWS has been widely performed in China, the current situation of CWS is still unclear. This study is the first study to investigate the current situation of surgical treatment for rib fractures in China.

Our investigation showed 30.87% cases were performed in hospitals lower than grade III-A hospitals and 43.92% cases were performed by residents and attending doctors, which suggested the technique requirements of CWS may not be too high. The lower technical requirements make it very easy to popularize and apply CWS, which is confirmed by the rapid increased volume of CWS in 2017.

Our investigation also showed not all the CWS were performed by thoracic surgeons in China. It is generally accepted that rib fractures are usually associated with several complications, such as diaphragm rupture, intercostal blood vessel bleeding, pneumothorax and so on. For non-thoracic surgeons, lacking experience in dealing with above diseases may result in misdiagnosis, poor treatment effect and delayed treatment. So it is very important to ascertain the division of CWS.

Most surgeons believed that CWS should be performed for patients who had three or more displaced rib fractures, or flail chest, or patients with rib fractures needing thoracic surgeries for other reasons, or patients with chest wall deformity, or patients with severe pain cannot be relieved by conservative treatment. Compared with conservative treatment, most surgeons believed CWS can achieve better outcomes. However, our investigation also showed that it was not a minority to perform CWS for single rib fracture and two rib fractures. We can see that there is an obvious contradiction between the widely accepted operative indication and the specific operative indication. Although many studies about CWS have been published recently, no large-scale RCT studies on operative indication of CWS have been reported yet. Under this circumstance, it is very difficult to formulate a widely accepted guideline for CWS.

It is generally accepted that early fixation of rib fracture can reduce the rate of complications such as severe hematoma, inflammation, empyema, clotted hemothorax and so on. Previous study suggested the optimal operation intervention time for rib fractures was within 72 hours after injury [8]. Our investigation showed most CWS cases were performed within two weeks. However, there were still 42.2% surgeons performed CWS for patients with rib fracture more than two weeks. Although most surgeons believed CWS should be performed for patients with rib fracture more than two weeks in some special cases, there was not sufficient data to evaluate the surgical outcomes of above patients. Whether CWS is needed and feasible for patients with rib fractures more than two weeks is still controversial.

It is generally accepted that CWS for ribs 1 and 2 and paraspinal rib fractures and costal cartilage fractures is not necessary since they are very difficult to expose while contributes little to respiratory physiology [9]. Likewise, CWS for ribs 11 and 12 and dislocation of sternoclavicular joint is also not suggested for the same reasons. Our study showed partial surgeons had performed CWS for above patients easily. Since operation requirement is not the major obstacle in China, whether it is necessary to perform CWS for above patients is the question we should answer in future.

Whether internal fixation should be removed after CWS remains controversial. Our investigation showed only 33.93% of surgeons chose to remove internal fixation at one year after surgery. Operative morbidity, secondary rib fractures are the main obstacles for surgeons to remove internal fixation. Patients' requirement, discomfort symptoms after CWS are the major reasons for patients seeking for internal fixation removal. Degradable material to fix bone fracture has developed rapidly in the past decade. It is expected the application of degradable material may solve the conflict between surgeons and patients.

Our investigation showed the rate of surgical treatment for multiple rib fractures is still very low in China. Under this circumstance, large-scale RCT studies on operative indication, developing better internal fixation materials, propagating technical experience, reducing operation related costs, giving attention

and support from relevant academic organizations and activities, giving support from hospital management department or other departments are very important for the further development of CWS, which are also the major work we need to do in future.

Conclusions

In conclusion, although CWS has been widely performed and rapidly developed in China, consensus about operative indication, timing and technical details for CWS is not formulated yet. Irregularities and chaos are existed in whole processes of CWS. Lacking literature and evidence support remains a major obstacle for developing CWS in China. Large-scale clinical trial and high-level literature are wanted.

Abbreviations

CWS: chest wall stabilization; ICU: intensive care unit; RCT: randomized controlled trial

Declarations

Ethical Approval and Consent to participate

The study was approved by Ethics Committee of Shanghai Jiao Tong University Affiliated Sixth People's Hospital.

Consent for publication

Not applicable.

Availability of supporting data

The data that support the findings of this study are available from Shanghai Jiao Tong University Affiliated Sixth People's Hospital and are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Author contributions

Zhao WG, He WW conceived and designed the study. Zhang Q, Yang JL, Wu WW and Ning SN collected and assembled data. Huang G performed data analysis and interpretation. Yang Y contributed to manuscript writing. All authors read and approved the final version of the manuscript.

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Figures

Figure 1

The algorithm of patient selection.

Figure 2

The constituent ratio of the hospitals in this study.

Figure 3

The constituent ratio of surgeons who had treated rib fractures in this study.

Figure 4

The constituent ratio of surgeons who had perform CWS in this study.

Figure 5

The volume of CWS in 2016 and 2017.

Figure 6

The potential advantages of CWS in the surgeons' opinion.

Figure 7

The operative indication of CWS in the surgeons' opinion.

Figure 8

The reasons why surgeons perform CWS for patients with rib fractures more than two weeks.

Figure 9

The rate of CWS for different locations of rib fractures.

Figure 10

The reasons why surgeons remove internal fixator.

Figure 11

The factors restricting the development of CWS.