Editorial by article from Thomas White—"*Rib fracture repair*"

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In this current edition of *Shanghai Chest*, White *et al.* presented an overview concerning several aspects of the operative treatment of rib fractures. After a brief explanation of recent literature, they illustrated the three most common invasive approaches for rib fixation. They described the subscapular, inframammary and posterior approach including all technical details. As the authors stated, whilst in the past the latissimus dorsi muscle was transected, it is now common to use the muscle sparing approach, by mobilizing or only splitting the latissimus dorsi. This approach is beneficial for post-operative morbidity and functional recovery (1,2). Finally, the question that should perform this surgical procedure, with respect to osteosynthesis principles and learning curve is discussed. Once the decision for surgery is made, the surgical procedure is not the most difficult part in the treatment of this population. The indication however is still much debated.

Indication for rib fracture fixation

In this regard, there is still a paucity of prospective studies. However, there is increasing enthusiasm in many trauma centres to perform rib fixation. As the level of evidence is still limited, caution should be taken in this population in order to prevent overtreatment. The available evidence of rib fixation mainly focuses on patients with clinically evidence of a flail chest. For these patients with flail chest, only three randomized controlled trials (RCTs) are available, representing just 60 patients who underwent rib fixation altogether. These three studies in patients with flail chest, despite all their shortcomings, demonstrated reduced need for mechanical ventilation, reduced intensive care unit (ICU) stay, less pain and less pneumonia in patients after rib fixation.

Two of the studies performed rib fixation on patients with a flail chest who were ventilator dependent without prospect on successful weaning and all three studies had different strict exclusion criteria, such as severe injuries to other body systems, head trauma, or no development of respiratory failure (3-5). With regard to flail chest, different definitions are used in literature. Definitions vary from clinical flail chest to radiological flail chest defined as at least three consecutive ribs fractured in two or more places (4-9). However, guidelines from surgical critical care suggest four or more consecutive rib fractures on two places. Tanaka excluded patients with less than six rib fractures in their flail chest study (3). Following the majority of studies, flail chest should be defined as at least three consecutive rib fractures in more than one place. All other definitions can be regarded as a flail segment and might cause less pulmonary problems. Because of this heterogenicity in definition of flail chest, studies are difficult to compare and there is still no clear indication for rib fixation.

The second and far larger group of patients are those with multiple (three or more) rib fractures without flail component. This group is even more interesting from economic point of view, because of their need for hospital facilities. In patients with multiple rib fractures, age and number of fractures are important outcome predictors (10,11). Many of the complications of rib fractures might be related to pain, which results in impaired breathing. Optimal pain management improves breathing, but cannot always be achieved by analgesia. In patients with insufficient pain control, rib fixation might be a suitable option (12-14). However, evidence is once again scarce. In a retrospective

study, Qiu *et al.* found that patients with multiple rib fractures without flail segment showed good short term results and an earlier return to 'normal activity' after rib fixation (15). Another study on multiple rib fractures from Khandelwal *et al.* reported a significant reduction of pain and earlier return to work after rib fixation (16). No other studies reported results of rib fixation compared to nonoperative treatment in patients with multiple rib fractures.

Possible or relative contraindications

Voggenreiter *et al.* (17) stated that the presence of pulmonary contusion associated with flail chest is a contraindication for rib fixation. However, the power of this study is limited with only very small groups of patients. Therefore the contribution of pulmonary contusion to success or failure of rib fixation still remains questionable. Pulmonary contusion was diagnosed by evidence of an acute infiltrate on the admission chest radiograph and by fibre-endoscopic bronchoscopy within 4 hours after admission. However a pulmonary contusion can deteriorate considerably within 24 hours, so diagnosing within 4 hours after trauma may underestimate the incidence of pulmonary contusion. Other studies showed contradictory results. Althausen *et al.* described a possible benefit of rib fixation in patients with pulmonary contusion, compared to non-operatively treated patients (18). Tanaka *et al.*, described no difference in pulmonary contusion between the operatively and non-operatively treated patients, suggesting that pulmonary contusion does not play a significant role in the indication for rib fracture fixation (3). During the current screening of polytraumatized patients, the whole body CT scan is increasingly used in emergency departments. With the use of a three-dimensional computed tomography the volume of the pulmonary contusion can be measured which might be helpful to identify patients at high-risk for respiratory failure (19).

Surgical technique

The described invasive surgical approaches might cause pain. Especially in obese patients, the surgical approach is often more extensive and fractured ribs are harder to find. Preoperative ultrasound can be very useful in localizing rib fractures. Together with the use of the Alexis® retractor, or as described by White *et al.*, Thompson retractor®, approaches can be limited to 4–10 cm. When necessary, separate stab incisions can be made. Several tools for minimal invasive rib fixation, including angular drilling systems, have been developed recently. The development of these minimal invasive techniques may result in less pain due to a more restricted surgical approach (20).

Evidence based medicine

The last decade there has been growing experience with rib fixation, which resulted in an increased number of publications on this subject. Most studies concluded that more RCTs should be performed. However, the number of RCT's on this subject didn't increase at all in the last decade and that might be for a reason. RCTs in trauma surgery are difficult to conduct. One of the most common challenges of RCTs is the timely and efficient recruitment of patients. Several studies have shown that RCTs in surgery have low patient participation rate (21). Patients are often hesitant to participate in trials as they do not want their (surgical) treatment to be decided by chance. If patient recruitment is not carried out properly, an extended trial period and increased costs are to be expected, or the RCT might fail altogether.

Physicians in surgical trials also influence the low participation rate, as they often prefer one of both treatment arms. Treatment preference results in less participating centers or selective inclusion of patients. This holds especially true for new surgical techniques like rib fixation. Introduction of a new technique might result in confounding due to the complexity of the procedure. The technical difficulty of a surgical procedure cannot be compared to, for example, administering drugs. A surgical procedure can be influenced by many other factors, such as the expertise and experience of the surgical team.

Last but not least, RCTs must be performed according to strict rules and require budget for approval by medical ethical committees and monitoring of the trial. In a field with limited financial resources, such as trauma surgery, these regulations might lead to a decrease in the quantity of RCTs.

More research is needed to further identify the right type of injury pattern and right patient for rib fixation. As previously mentioned, RCTs in this heterogenic population are very difficult to perform and for adequate subgroup analyses sufficiently large sample sizes are needed. Observational studies might be an achievable first step in gathering high quality evidence.

Now how to proceed? The most important questions remains: to fix or not to fix? And if so, who should we fix.

Age and number of fractures are important in predicting outcome, but cannot solely be used as indication for surgery. The most important symptom in patients with rib fractures is pain, as pain might result in impaired breathing possibly leading to a cascade of complications. The relationship between dislocation of fractures and pain has not yet been established. In our search for the right indication for rib fixation, pain seems to be underestimated as an important factor. If pain management is optimized but still inadequate, patients might benefit from rib fixation. Future studies are desperately awaited, but for the present we recommend to be very critical in determining the operation indication.

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Footnote

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