

The novel use of Nuss bars for reconstruction of a massive flail chest

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We present the case of a patient who sustained a massive flail chest from a snowmobile accident. All ribs of the right side of the chest were fractured. Nonoperative management was unsuccessful. Previously reported methods of rib stabilization were precluded given the lack of stable chest wall elements to fixate or anchor the flail segments. We present a novel surgical treatment in which Nuss bars can be used for stabilization of the most severe flail chest injuries, when reconstruction of the chest is necessary and fixation of fractured segments is infeasible owing to adjacent chest wall instability.

CLINICAL SUMMARY

The patient was a 40-year-old male snowmobile driver who was hit by a train. Evaluation revealed severe multiple right-sided rib fractures, right scapular and clavicular fractures, and a left femur fracture. A thoracostomy tube was placed and intubation with mechanical ventilation instituted. With stability, he was taken for intramedullary nailing of the femur. Despite conventional efforts, he was unable to be weaned from the ventilator inasmuch as he consistently had hypercapnic respiratory failure with weaning trials. Additionally, a worsening pneumonia developed on the side of the injury. Computed tomographic scan with 3-dimensional reconstruction (Figure 1) revealed fractures of the sternum and every rib on the right side (some at multiple sites, some near their attachment to the spine). A plan for the novel use of Nuss bars was devised. Heretofore, Nuss bars have been used for correction of pectus excavatum in children and adolescents. The surgical plan was as follows.

A long incision from the base of the neck past the tip of the scapula curving to the abdomen with division of latissimus and serratus muscles exposed the chest wall. Three Nuss bars were placed in a vertical position: an 11-cm bar in the most posterior position, a 12-cm bar in the midaxillary position, and another 12-cm bar in an anterior position. They were secured superiorly to the second rib and inferiorly to ribs of the lower cage. The Nuss bar endplates were secured to the bars with sternal wire. Thoracotomy incisions were made in the fourth and eighth intercostal spaces, allowing



FIGURE 1. Posterior view of 3-dimensional computed tomographic scan showing reconstruction of massive flail chest used during preoperative planning.

entry into the chest and elevation of the chest wall and rib fractures to the Nuss bar superstructure. Ribs were secured to the undersurface of the Nuss bars with polydioxanone sutures (PDS sutures; Ethicon, Inc, Somerville, NJ). A horizontal Nuss bar was attached to the vertically placed bars for additional stability. This bar was stabilized to the erector spinae muscles posteriorly and the costal cartilages anteriorly. After re-expansion of the right side of the chest, there was difficulty reapproximating ribs of the intercostal portion of the thoracotomy incision, and an Alloderm patch (LifeCell Corporation, Branchburg NJ) was used to enlarge the chest wall, providing a tension-free closure. Thoracostomy tubes and drains were placed and final closure was performed. Physical examination and chest radiography revealed a near symmetrical chest wall with pulmonary re-expansion (Figure 2) allowing extubation on postoperative day 9. He was transferred for rehabilitation and continues to do well.

DISCUSSION

Several prospective studies have concluded that surgical stabilization results in less time supported by mechanical ventilation, lower incidence of pneumonia, and shorter intensive care unit stays in patients with more severe injuries.¹⁻³ Cases of severe flail chest involving six to ten costal levels have been described, with surgical management using various materials including prosthetic mesh with

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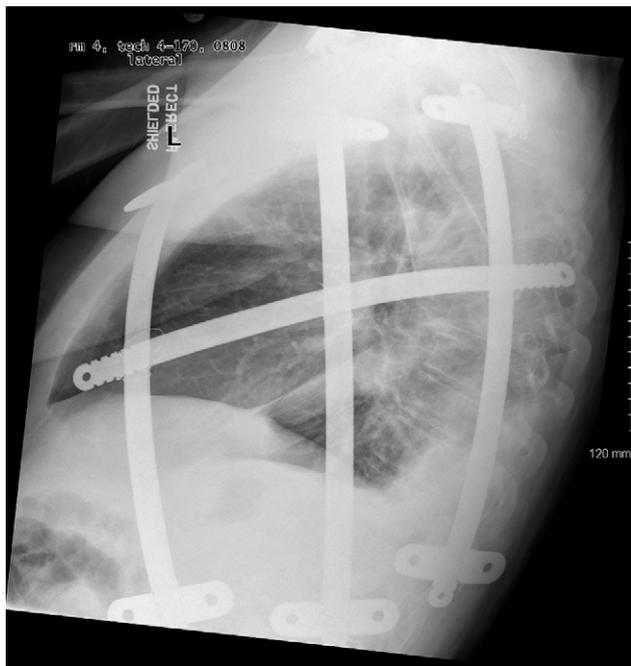


FIGURE 2. Lateral chest radiograph showing lung re-expansion and Nuss bar relationship in the final chest wall construct.

methylmethacrylate and osteosynthesis plates to stabilize a rib segment to an intact portion of the same or adjacent ribs.^{4,5} Our patient's injuries precluded other described techniques owing to the lack of intact structures to anchor stabilizing components. Our novel use of Nuss bars enabled us to create a viable superstructure to suspend the chest wall and allow full re-expansion of the lung. This technique will be

useful in patients whose severity of injury precludes stabilization by previously described methods.

We corresponded with Dr Donald Nuss for his thoughts. He wrote:

This is a very novel and effective method of chest stabilization, which rescued a critically ill patient. A question that arises is whether the bars need to be removed after the patient has fully recovered. They may never require removal, but if the patient becomes symptomatic it will be somewhat of a challenge to remove them as they have stabilizers on each end. The use of absorbable sutures was a very good idea, and if the situation arises again I would recommend using absorbable stabilizers on each end so that after 6 months the bars can be extracted through small incisions.

We appreciate Dr Nuss' comments and will incorporate his suggestion in the future.

We thank Dr Donald Nuss for his review and comments.

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Near-fatal bleeding after transmyocardial ventricle lesion during removal of the pectus bar after the Nuss procedure

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In 1998, the technique of minimally invasive repair of pectus excavatum (MIRPE) was first described by Nuss

et al.¹ This procedure is reported to be less invasive and to achieve cosmetically better results than conventional surgery, and has been introduced in many centers.^{2,3} Because of the widespread use of MIRPE, pediatric surgeons are faced with a new spectrum of complications.²⁻⁵ Cardiac perforation represents a rare but potentially serious condition that has to be taken into consideration when dealing with MIRPE. There are several reports of cardiac perforation during implantation of a pectus bar within the MIRPE procedure.^{2,3,5} However, this is the first report of a life-threatening transmyocardial ventricle lesion during removal of the bar.

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