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Conservative Treatment of 'Flail Chest' following Non-Union Fractures of the Thoracic Rib Cage with Secondary Shoulder Pathology: A Case Report

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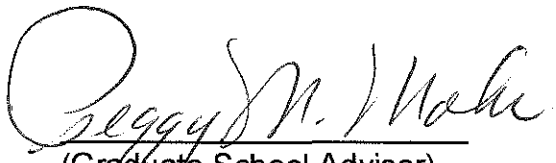
This Scholarly Project, submitted by Chase Kerber in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.



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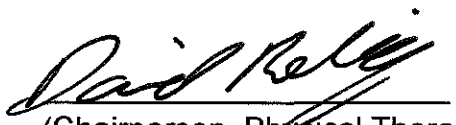

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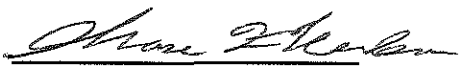
Signature 

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ABSTRACT

Background and Purpose – Fractures of the thoracic ribs are common injuries with a high incidence of secondary co-morbidities which may require a slower rehabilitation progression and result in a delayed return to full function. Patients with these diagnoses often seek physical therapy intervention in order to regain their prior level of function.

Case Description – A 51 year-old male sustained multiple rib fractures, pneumothorax, and a left shoulder injury as a result of falling backwards off a 6 foot platform. He presented to physical therapy for evaluation and treatment with the goal of returning to his occupation as a delivery driver. The plan of care consisted of therapeutic exercise and patient education.

Intervention – Interventions consisted primarily of therapeutic exercise. Additional interventions included patient education related to proper body mechanics, pacing, exercise instruction, work modifications, and posture.

Outcomes – A home exercise program (HEP) was completed over 5 weeks and resulted in a significant reduction of pain (0-1/10) and return to work at a full functional level.

Discussion – Although treatment of flail chest is well documented, current clinical guidelines do not mention which treatment options will optimize recovery.

In this case study, therapeutic exercise and patient education were used to facilitate the return to full function.

CHAPTER I

BACKGROUND AND PURPOSE

Fractures of the thoracic ribs secondary to blunt force trauma are believed to be very common and have been documented in as many as two thirds of cases with chest trauma. [1] In a review conducted by Ziegler et al,[2] a diagnoses of chest trauma was seen in 7147 individuals and 10% of these patients were admitted to a trauma center with radiographic evidence of rib fractures. Fractures of the ribs are one of the most common injuries in the elderly and account for approximately 12% of all fractures sustained by the older population with an increasing incidence as that population ages. However, the true incidence of thoracic rib injury may be under-reported as up to 50% of these fractures may be undetected on radiographic imaging.[3]

The morbidity and mortality of patients who have experienced blunt force trauma are significant. Zeigler et al[1] reported that 6% of 711 patients with blunt trauma to the chest died and approximately 54% of those deaths were directly related to secondary pulmonary complications. The mortality of isolated flail chest has been as high as 16%.[4] The associated costs of blunt chest trauma and secondary pulmonary complication may include admittance to ICU units, use of ventilation devices, loss of wages and associated therapy. The summation of costs from these various areas would presumably lead to a substantial amount.

Historically, chest trauma injuries were treated through use of "internal pneumatic stabilization" with positive pressure mechanical ventilation.[5]

Dittmann[6] concluded that conservative intervention was beneficial for patients with flail chest when treated with epidural analgesics and physical therapy while intubation and ventilation were withheld. Seventeen of the 19 participants were managed successfully with these interventions alone. Current treatments of rib fractures associated with blunt force trauma to be centered on optimization of pain control, chest physical therapy, and noninvasive positive pressure ventilation in the cases with secondary pulmonary involvement.[7] The purpose of this case report was to highlight the interventions and outcomes utilized for treatment of a patient with thoracic rib fractures experiencing secondary shoulder pathology who also had pulmonary involvement.

CHAPTER II

CASE DESCRIPTION

A 51 year-old male presented to physical therapy for evaluation and treatment of multiple rib fractures and left shoulder pain, which he had sustained approximately 4 months previously. The patient was a white, English-speaking male with a high school education, who was right handed.

The fractures occurred at his lake home as the result of falling backwards off of a 6 foot platform and impacting a concrete slab. The patient was brought to the emergency department for evaluation immediately after the injury occurred. On arrival, the patient had difficulty breathing which met criteria for radiological imaging to be performed. Radiographic findings showed multiple left sided rib fractures (Figure 1), secondary pneumothorax, and left shoulder trauma. The patient was currently living with his wife, in a home in an urban setting, with readily available access to multiple medical facilities and personnel. All of these

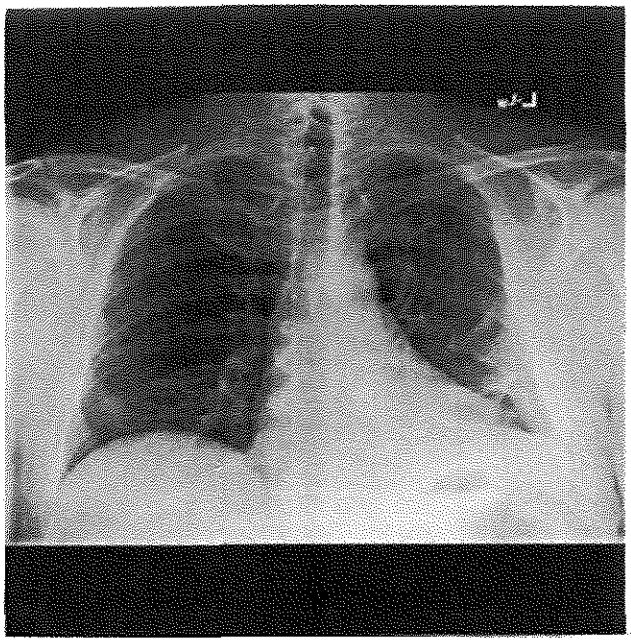


Figure 1: Radiograph of multiple left side non-union rib fractures and persistent left basilar atelectasis

services and personnel were available to assist in his recovery as needed. The patient did not use any assistive devices prior to his injury.

The patient worked for a delivery company delivering packages, which was a labor intensive occupation requiring the lifting of packages up to 70 pounds for up to 9 hours a day. Due to these factors, he was in good physical health and able to perform all work related activities with vigor and without any complications prior to his injury.

His social activities included spending weekends at his lake home. He reported social behavior of consuming alcohol on the weekends, rarely in a binge fashion and without dependence. Per patient report, his mental health history was unremarkable.

Family history was unremarkable with no known heart disease, diabetes, or genetic disorders and the patient denied any prior hospitalizations or surgeries. His past medical history including management of the pneumothorax sustained during the current injury and a nonrelated left abdominal wall hernia. The patient sought physical therapy prior to his return to work due to concerns that he would not be able to participate in the heavy, repetitive lifting required for his occupation as a delivery driver. He was currently restricted to lifting only 25 pounds as per doctor's orders. Initially, he had been applying ice to his left shoulder and ribs which he had discontinued approximately one month prior to seeking therapy. He had been completing light dumbbell exercises at home utilizing 8 to 15 pound weights. The patient reported he was not currently taking any medications for management of his pain.

As mentioned previously, the patient's prior functional status and activity level for completion of all activities of daily living (ADL's) and instrumental activities of daily living (IADL's) was unremarkable while completing tasks at work or home. Current limitations included difficulty sleeping, driving, and completion of overhead movements with his left upper extremity. He had not returned to work since sustaining his injury, although he had contacted his employer and he was willing to make job modifications for the patient if necessary.

Examination, Evaluation and Diagnosis

During initial evaluation, the patient's resting heart rate, blood pressure, and respiratory rate were 72 bpm, 122/78 mmHg, 16 breaths per minute, respectively. His weight was 252 pounds and he was 6'3" tall, which produced a body-mass index of 31.49 kg/m^2. This value is classified as 'obese' by the American College of Sports Medicine.[8]

Palpation of the left shoulder revealed tenderness along the greater tuberosity with no noticeable edema present. Palpation of the left ribcage revealed tenderness over the anterolateral inferior ribs and the abdominal wall immediately distal to the lower ribs. There was no edema or bruising evident and his integument was intact and unremarkable.

The patient's posture, inspected in standing with lateral and anterior views, included rounded shoulders and slight forward head. Posterior observations revealed that his right shoulder was positioned lower than his left,

although within normal limits due to right handedness. No other postural abnormalities were discovered.

Gross assessment of his range of motion found 50%-75% limitations in all motions of the thoracic spine. His lower extremity movement was within normal limits for all motions of the hip, knee, ankle, and foot, bilaterally. His right upper extremity range of motion was within normal limits for all motions of the shoulder, elbow, wrist, and hand. His left upper extremity ranges were limited in flexion and abduction by approximately 20 degrees (Table 1).

Table 1
Shoulder Active Range of Motion & Strength on Initial Examination

Left Shoulder	**AROM (degrees)**	**Strength (_/5)**
Flexion	160	4+ c/o pain
Abduction	160	4+ c/o pain
Adduction	WNL	4+ c/o pain
Internal Rotation	WNL	5
Extension	WNL	5
External rotation	60	4+ c/o pain

Gross strength of the trunk was assessed through resisted isometrics and was performed with the patient seated. Motions were rated utilizing the standard 5-point manual muscle testing (MMT) scale with a rating of 5/5 being defined as 'normal' strength. All motions were 5/5 bilaterally with the patient reporting minimal pain during rotation and lateral flexion of the trunk, bilaterally. Lower extremity strength was not assessed due to no observable impairments being

noted and no patient complaints. Right upper extremity strength was 5/5 with all motions tested utilizing standardized MMT positions and ratings.

Table 2
Shoulder Active Range of Motion & Strength on Final Examination

Left Shoulder	AROM (degrees)	Strength (_/5)
Flexion	170	5
Abduction	170	5
Adduction	WNL	5
Internal Rotation	WNL	5
Extension	WNL	5
External rotation	68	5

Left upper extremity strength limitations were seen in shoulder flexion, abduction, adduction, and external rotation and can be found in Table 1. Serratus anterior strength was assessed and was 5/5 bilaterally and pain-free. Abdominal strength testing revealed weakness and was scored 4+/5.

Observation of the patient in both sitting and during ambulation did not warrant direct balance or locomotion assessment as the patient was steady with both static and dynamic movements. The patient was independent in all transfers. There were no communication barriers present during treatments and the patient was conscious and oriented to his person, place, time, and context (x4) throughout the course of his rehabilitation. The patient's preferred method of learning was through hands-on demonstration followed by practice and therapist feedback.

A shoulder pain and disability index (SPADI)[9] was completed by the patient on initial evaluation to determine his level of perceived disability and he received a total pain score of 36%, total disability score of 27.5%, and total SPADI score of 30.8%. This test was chosen due to the ability to be self-administered, its high concordance to the Visual Analog Scale (VAS) (intraclass correlation coefficient = 0.86), and the ability to accurately discriminated between subjects who improved versus those who stayed the same or worsened [receiver operating characteristic cure, (ROC) = 0.91, likelihood ratio for improvement = 34]. The conclusion of a study conducted by Williams et al[9] found that the SPADI was highly correlated with the original VAS version of the SPADI and other measures of health status. The SPADI was responsive to change and accurately discriminated among patients who are improved or worsened.

Special tests performed during initial evaluation of the physical therapy treatment included the empty can, Hawkins Kennedy, and Speeds tests. All tests were positive due to pain. A study conducted by Hegedus et al[10] concluded that the diagnostic accuracy of the Hawkins-Kennedy test for impingement and the Speed test for labral pathology was limited. Sensitivity and specificity for the Hawkins-Kennedy test was 79% and 59%, respectively, and for the Speed test was 32% and 61%, respectively. The sensitivity and specificity of the empty-can test has been reported as 86% and 50% by Leroux et al.[11] High false-positive results and low specificity of the test in full-thickness tears along with a lack of correlation between the functional impairment and size of the tear were reported.

The patient's rib motion was assessed during initial examination while lying in supine. The therapist placed a hand on either side of the patients rib cage lateral to the sternum and asked the patient to inspire as deeply as possible in order to assess if the ribs were moving in synchrony or if there was incongruence between sides. Following five deep breaths, it was determined that the patient's ribs were moving in synchrony bilaterally. Costovertebral expansion was also assessed and was considered to be within normal limits.

After the initial examination, it was evident that pathology was present in the left shoulder. It was thought that the patient had an impingement in the left shoulder due to the weakness found in the rotator cuff musculature, rounded shoulders posture, and muscular instability affecting the attachment sites near the areas of his rib fractures. All of these factors could disrupt joint congruency, possibly due to the muscles not having a sturdy anchor site in which to transfer force.

Impairments from the initial injury included decreased thoracic and shoulder active range of motion and decreased trunk and scapular strength. Weaknesses in stabilizing musculature produced functional limitations in reaching, bending, and lifting. These limitations produced a disability affecting his work as a delivery driver and an inability to reach overhead to grab packages necessary for his occupation. It was evident that physical therapy interventions would need to address pain management, improving range of motion and strength, as well as, preventing any additional deconditioning that may have occurred during his time away from work.

The examination data resulted in the diagnosis of multiple rib fractures resulting in flail chest (ICD-10 code: S22.50), and left shoulder pain (ICD-10 code: M25.51). With the patient's current pathology and symptoms, his pathology would be classified as in physical therapy practice patterns 4G: Impaired Joint Mobility, Muscle Performance, and Range of Motion Associated With Fracture, and Pattern 4C: Impaired Muscle Performance.[12]

Prognosis and Plan of Care

Other than the limitations existing within his left upper extremity and trunk, this patient presented with no other pathologies. The SPADI[9] offered no predictive abilities in reference to this patient's outcomes. However, with his decreased muscle function and current signs of pain limited to certain movements, it was expected this patient would have a significant reduction in symptoms and a return of left shoulder function with properly implemented physical therapy over the following months. Although his trunk range of motion was limited, this patient did not have extensive pain associated with the non-union fractures present in his left ribs. This fact greatly improved his prognosis simply because pain with trunk movements can be severely limiting during certain therapeutic interventions.

Due to the fact that his job was labor intensive and necessitated putting considerable stress through his trunk and shoulders, limitations would likely need to be implemented prior to his return to work in order to gradually progress the

stress exposed to his left shoulder and trunk. The patient was scheduled to participate in physical therapy 2 times per week for a period of 6 to 10 weeks, based off patient needs and expectation of weekly progression of a therapeutic exercise program.

Short term goals consisted of independence in a home exercise program, progression of core strengthening exercises, improvement in active range of motion of the shoulder and trunk, and a decrease in perceived pain. Long term goals included completion of all work related activities with minimal to no increase in pain, reduction of his SPADI score to half his initial evaluation numbers (less than 16%), and improvements in abdominal/trunk and shoulder strength. Discharge criteria were set based on these long-term goals, particularly his ability to perform all work related activities with minimal pain.

Throughout the duration of this patient's physical therapy, all documentation was completed electronically and stored within the clinic's health record system. This allowed anyone within the health system treating this patient access to the physical therapy progress notes, which also allowed the therapists to stay current with any new medical diagnoses.

The patient was educated and instructed in the performance of a daily home exercise program (HEP) in conjunction with 2 physical therapy appointments each week for a duration of 45 minutes each visit. The HEP was designed to maintain improvements in range of motion and strength gained from completion of the therapy interventions, as well as, decrease the associated pain present in his shoulder and ribs.

Interventions were organized to progress the patient toward the set physical therapy goals. Therapeutic exercise was completed each physical therapy session and consisted of exercises to increase strength and mobility within the left shoulder. Progression of the patient's ability to lift and carry a certain amount of weight in a repetitive nature, which also stressed his thoracic and abdominal musculature, was also implemented during therapy.

Intervention

During weeks 1 and 2 of treatment, therapeutic exercise included active range of motion (AROM) exercises of shoulder flexion in the sagittal and scapular planes, horizontal abduction, bilateral external rotation with a green resistance band (shoulders in 0° of abduction), bilateral shoulder abduction, 'W's (horizontal abduction with shoulders at 0-10° of abduction and elbows at 140-150° of flexion), and shoulder extension, focusing on scapular stabilization to situate the humeral head properly within the glenoid. Core strengthening exercises consisted of dead bug progression, resistance band anti-rotation with various lever arms and resistances, and side planks. Patient completed shoulder strengthening exercises listed above for 1 set of 15 repetitions. Core strengthening exercises were completed from 30 to 60 seconds for 1 to 2 sets.[13]

Figure 2a: Resistance band anti-rotation starting position

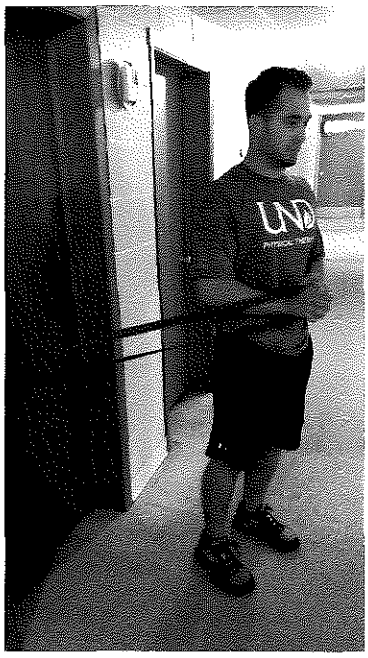
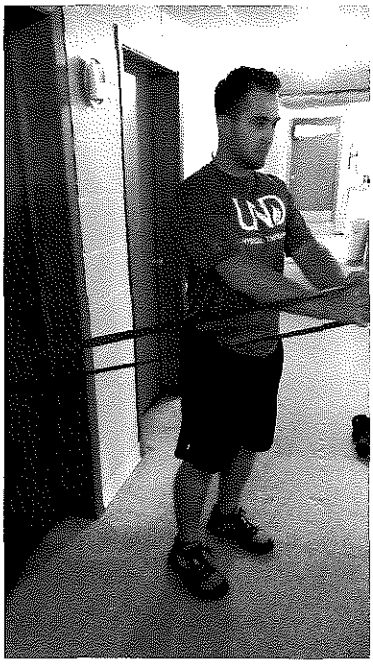


Figure 2b: Resistance band anti-rotation ending position



Following only 2 weeks of therapeutic exercise, the patient's shoulder pain had improved with a reduction from a 6-8/10 during initial evaluation to a 1-2/10 during activity. This was thought to be due to the patient's consistent compliance with his home exercise program. The patient reported that he was completing the prescribed exercises at home 2-3 times per day with 2 sets of 20-30 repetitions. His rib pain had also decreased from a constant 2-3/10 to a 1/10 at rest.

During weeks 3 and 4, exercise selection shifted to more functional, weight shifting/lifting, and carrying activities. The patient completed repetitive functional lifts to mock the activities he would be performing during his job. These exercises consisted of loaded carries with weight ranging from 25-45 pounds for 200 feet, floor to waist lifts of 30-50 pounds for 5 repetitions, waist to shoulder lifts with 30-50 pounds for 5 repetitions, shoulder to table lifts utilizing 50 pounds for 3 repetitions, shoulder to waist lifts with 50-70 pounds for 5 repetitions, and pushing/pulling a weighted sled from various hand holds on both tile and carpet

for 50 feet with 50-120 pounds for 5 repetitions. During completion of these exercises, the patient was cued to keep his neck musculature relaxed, focus on his shoulder and scapular musculature, and maintain an active core to promote stability in his ribs while carrying the heavy loads. Repetitions for these exercises varied slightly between sessions, depending on the patient's symptoms during exercise performance.

The last treatment session was reserved for completion of a repetitive functional lifting circuit as an assessment of his functional capacity. The above functional exercises were utilized and performed continuously for 3 bouts of 10 minutes, with 2 minutes of rest between successive circuits, for a total of 30 minutes of nearly continuous functional lifting and carrying activity.

Throughout the course of this patient's therapy, he was encouraged to apply ice to his left shoulder, following any activities which increased his shoulder pain, to help mitigate the amount of pain and inflammation that may have been brought on due to the increase in activity associated with his therapeutic exercises.

Outcomes

At the conclusion of 4 weeks of treatment, the patient demonstrated significant improvements in AROM and strength of the left shoulder and increased trunk range of motion to within normal limits. Improvements in shoulder AROM and strength are in Table 2.

On this patient's last day of scheduled therapy, the SPADI[9] was re-administered. The patient received a total pain score of 16%, total disability score of 6.35%, and a total SPADI score of 10%. Initial total SPADI scores were 36% meaning that this patient saw a significant improvement in shoulder function with a total improvement of 20.8%. With this improvement, the patient had reached all short and long term goals set following initial evaluation.

The patient was not scheduled to return to work for another 2 weeks following discharge from therapy. He was instructed to continue his HEP until his return to work. The patient was contacted via telephone 4 days after he returned to work to ascertain if he was coping with the demands necessary for completion of his delivery job. The patient reported some muscle soreness following the first 2 days of his return to work after which point it resolved. He also reported no pain while completing his work-related activities but decreased endurance and aerobic capacity from his pre-injury levels. He stated that he was able to complete all lifting and carrying of packages necessary over an extended time. Overall, the patient voiced satisfaction with his therapy, outcomes, and ability to return to work with minimal discomfort.

CHAPTER III

DISCUSSION AND CONCLUSIONS

In reference to this case study, it is likely that the facilitation and progression of shoulder and core strengthening exercises, provided within the patients HEP, were directly related to his decrease in pain and increase in strength resulting in his return of function and ability to participate in all work related activity. Literature was not found specifically addressing the use of therapeutic exercise as a singular treatment of flail chest; however, findings from this case study suggest that therapeutic exercise alone may be an effective means to treat flail chest in the absence of limiting pain.

As mentioned previously, treatment of flail chest often includes significant reliance on analgesics for participation in therapeutic exercise during rehabilitation.[14] As this patient did not have severely limiting pain and, in fact, only minimal pain associated with his non-union rib fractures, one must take into account that most cases involving this particular diagnosis may not see such significant improvement and return to function.

Consequently, a combination of treatment approaches should be kept in mind when treating individuals with flail chest. Interventions may include, but are not limited to deep breathing, inspiratory/expiratory exercises, diaphragmatic breathing, soft tissue treatments, ultrasound, proprioceptive training to facilitate proper rib motion, and possible use of external bracing to help stabilize any non-synchrony present between ribs.[15]

Administration of a functional scale to track subjective improvements in trunk function is also recommended. Based on conclusions of Feise[16], the Functional Rating Index was deigned to show clinical change in conditions affecting the entire spine, it is recommended that this scale would be a better adjunct to evaluate therapeutic progress. However, the Oswestry Disability Questionnaire was also designed for the lumbar spine and could be used to track functional capacity of the thoracic spine as well.

To my knowledge, there are no functional scaled in existence that directly measure the outcome of patients with flail chest. Future research should be aimed towards development of a functional scale to measure disability and outcomes associated with this pathology.

Reflective Practice

Since completion of work with this patient, I have been fortunate to have had the opportunity to continue my education and further my understanding of how this individual's pathology may have been affecting the patient's function. While caring for this patient, I had not yet completed any formal cardiopulmonary class work. That being said, I did not have the necessary knowledge to perform auscultation of this patient's lungs. I believe that regular auscultation would have been appropriate during treatment sessions to ensure that the persistent basilar atelectasis was not exacerbated by any interventions provided throughout the course of treatment.

In addition, I have had the opportunity to increase my knowledge and understanding of musculoskeletal pain syndromes through an in-depth study of Sahrmann's musculoskeletal examination techniques. I believe the use of these principles would have aided treatment immensely due to the nature of this patient's injury and the multiple musculoskeletal abnormalities that I was trying to be mitigated.

Furthermore, I would have used a functional outcomes assessment with focus towards the patients trunk function, initially and upon completion of the plan of care, to track improvement and provide additional objective data to include in documentation.

REFERENCES

1. Shorr RM, Crittenden M, Indeck M, Hartunian S, Cowley RA. (1987). Blunt thoracic trauma: analysis of 515 patients. Ann Surg;206: 200-205Brotzman SB,

2. Ziegler AW, Agarwal NN (1994): Morbidity and Mortality of Rib Fractures. J Trauma.;37: pp.975-979

3. Trunkey DD (1986): Cervicothoracic Trauma. In Blaisdell FW, Trunkey DD (eds) Trauma Management Vol III. New York, Thieme.

4. Palvanen M, Kannus P,Niemi S, Pakkari J, Vuori I. (1998). Epidemiology of minimal trauma rib fractures in the elderly. Calcif Tissue Int;62: pp.274-277

5. Clark GC, Schecter WP, Trunkey DD. (1988). Variables affecting outcome in blunt chest trauma: Flail chest vs pulmonary contusion. J Trauma.;28 (pp. 298-304)

6. Dittmann M, Ferstl A, Wolff G. (1975) Epidural analgesia for the treatment of multiple rib fractures. Europ J Intensive Care Med.;1:71-75

7. Jensen NK. (1952). Recovery of pulmonary function after crushing injuries of the chest. Dis Chest: 22:319

8. Lippincott, W.W. (2014). Body Composition Status and Assessment. In W.W. Lippincott, *ACSM's Resource Manual for Guidelines for Exercise Testing and Prescription* (pp. 287-304). Philadelphia: Wolter Kluwer Health.

9. Trinkle JK, Richardson JA, Trany JL, Grover FL, et al. (1975)Management of flail chest without mechanical ventilation. Ann Thorac Surg; 19:355-63

10. Williams JW Jr et al. J Rheumatol. (1995). Measuring shoulder function with the Shoulder Pain and Disability Index.

11. Hegedus, Eric J., et al. (2008). "Physical examination tests of the shoulder: a systematic review with meta-analysis of individual tests." *British journal of sports medicine* 42.2 80-92.

12. Guide to Physical Therapist Practice. *Guidetoptpracticeaptaorg*. 2016. Available at: http://guidetoptpractice.apta.org/. Accessed May 25, 2016.

13. Kim, Eugene, et al. (2006). "Interpreting positive signs of the supraspinatus test in screening for torn rotator cuff." *Acta Medica Okayama* 60.4: (pp.223)

14. Brotzman SB, Manske RC. (2011) Shoulder Injuries. In: *Clinical Orthopaedic Rehabilitation An Evidence-Based Approach - Expert Consult.* 3rd ed. London:

Elsevier Health Sciences:82–210.

15. Simon, Bruce J. MD (2005). Pain Management Guidelines for Blunt Thoracic Trauma. Journal of Trauma-Injury Infection and Critical Care: November 2005 – Volume 59, issue 5 (pp. 1256-1267)

16. Feise R., Michael Menke J. Functional Rating Index. *Spine*. 2001;26(1):78-87. doi:10.1097/00007632-200101010-00015.