Charles University

Faculty of Physical Education and Sports

Proximal Humerus Fracture

Bachelor Thesis
April 2010, Prague

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Abstract

Title:

EN: Proximal humerus fracture CZ: Fraktura proximální části humeru

Thesis aim:

This thesis discusses the rehabilitation of a fracture in the proximal part of the humerus. It is discussed in a theoretical part and a practical part of which the latter part is emphasized. The theoretical part aims to explain the anatomical, biomechanical, and kinesiological properties of the human upper extremity. It also includes a special part concerning fractures, fracture rehabilitation and the epidemiology and etiology of the proximal humerus fractures in specific. The practical part concerns a woman, age 70, in the state of one month after fracture of the surgical neck of the humerus. The practical part aims to describe examination, therapeutical approach and conclusions of this stereotypical incident of fracture of the proximal humerus.

Clinical findings:

The most notable clinical findings in the examination were the reduced ROM in shoulder joint in the left upper extremity, with active flexion reaching 70° and active ABD 40°. Active movements were also accompanied with pain during some movements. Joint play in the glenohumeral joint was also restricted in all directions in the affected upper extremity. Functional movements involving the shoulder joint showed limitation and provoked pain.

Methods:

Methods used for the rehabilitation of this patient were focused on regaining ROM and adapting the patient to their current state by coping with ADL's. PIR techniques was used for muscle relaxation, manual methods to increase mobility and as the patient was suffering from asthma, breathing therapy and education was done both to aid therapy techniques requiring breathing and to adapt a more sufficient breathing pattern. PNF techniques were also introduced for future therapy, as the patient also needed to work on muscle strength. 5 therapy sessions were completed, each lasting from 1 to 1.5 hours.

Result:

Patient showed a significant increase of ROM. Results for active flexion was 100 ° and ABD was 85°. More importantly, however, was the improvement in the functional movements tested, allowing the patient more independence in everyday life. The patient also expressed a significant reduction of pain perception.

Conclusion:

As the patient started her rehabilitation at the clinic in the first session described in this thesis, progress was expected. However, after only 2 weeks of therapy, the patient showed a great recovery, and the prognosis for living an active life, and return of normal physical ability, as was experienced prior to the accident, is good.

Keywords:

Shoulder, Proximal humerus fracture, Surgical neck fracture, Fracture rehabilitation

Declaration

I hereby declare that this work is entirely my own, individual work based on knowledge gained from books, journals, reports and by attending lectures and seminars at FTVS.

I also declare that no invasive methods were used during the practical approach and that the patient was fully aware of the procedures at any given time.

Prague, April 2010

Acknowledgement

I would like to thank my family for all support they have given during my stay in Prague and in life in general. This support could not be appreciated enough. I would also like to show my gratitude towards my friends from all over the world. You have all taught me so much.

Also, all lecturers connected to FTVS also need to be shown appreciation for their tireless work in teaching students, over many decades, on how to be good rehabilitation workers.

I would also like to thank PhDr. Edwin Mahr PhD. for guiding me through the whole practical therapeutical process.

And most importantly I have to mention the careful supervision of Mgr. Jiřina Holubářová. She has with her great experience guided me through the entire process of the bachelor thesis. It is very much appreciated.

Thank you all.

Christer Vik Smetana
Prague, April 2010

Table of contents

1. Preface

This bachelor thesis is divided into two parts. In the first part the theoretical point of rehabilitation of status post proximal humerus fracture is discussed. It is divided into separate sections discussing anatomy of the upper extremity and the shoulder complex in particular, kinesiology of the upper extremity and the arm as a tool in everyday life, biomechanics of the upper extremity and its mechanical properties, various types of fractures and specifically proximal humeral fractures, types of rehabilitation with operative and non-operative methods and epidemiology and etiology. The theoretical part is merely a brief overview as the second part of the thesis was considered more important.

In the second part of the bachelor thesis the examination and therapy progress of a patient with the given diagnosis is discussed. A full examination and therapy execution is performed in accordance with the author's best knowledge and in cooperation with the advisor and supervisor of the bachelor thesis. Evaluations of therapy progress and conclusions of both examinations and therapy execution are included to point out and highlight the degree of success in the rehabilitation process.

The thesis is equipped with a list of literature, figures, explanation of abbreviations and application of board review, and can be found in the supplement.

2. General part

2.1 Anatomy of the upper extremity

The upper limb is associated with the lateral aspect of the lower portion of the neck. It is suspended from the trunk by muscles and a small skeletal articulation between the clavicle and the sternum – the sternoclavicular joint. Based on the position of its major component bones, the upper limb is divided into shoulder, arm, forearm, and hand (1) with shoulder and arm being discussed into more detail in this paper.

The Shoulder Girdle

The upper extremity is connected to the axial organ via the shoulder girdle. The shoulder complex is compiled from three true and two false joints, enabling the great range and variability of movement. These joints are: glenohumeral joint, acromioclavicular joint, sternoclavicular joint, false scapula-thoracic joint, false subdeltoid joint and joints connecting the ribs with the spine. (2)

The glenohumeral joint is the articulation between the head of the humerus and the glenoid fossa of the scapula, which is the ball and socket joint typically considered *the major shoulder joint*. The sternoclavicular and the acromioclavicular joints provide mobility for the clavicle and the scapula—the bones of the shoulder girdle. (3)

Sternoclavicular joint

The sternoclavicular joint occurs between the proximal end of the clavicle and the clavicular notch of the manubrium of the sternum together with a small part of the first costal cartilage. It is a synovial and saddle-shaped. The articular cavity is completely separated into two compartments by an articular disc. The sternoclavicular joint allows movement of the clavicle, predominantly in the anteroposterior and vertical planes, although some rotation also occurs. (1)

The sternoclavicular joint is surrounded by a joint capsule and is reinforced by four ligaments. (1)

Ligaments of the Sternoclavicular Joint

The strength of the SC joint depends on ligaments and its articular disc. **Anterior** and **posterior sternoclavicular ligaments** strengthen the capsule anteriorly and posteriorly. The **interclavicular ligament** strengthens the capsule superiorly. It extends from sternal end of one clavicle to the sternal end of the other clavicle. In between, it is also attached to the superior border of the manubrium. The **costoclavicular ligament** anchors the inferior surface of the sternal end of the clavicle to the 1st rib and its costal cartilage, limiting elevation of the pectoral girdle. (4)

Acromioclavicular joint

The acromioclavicular joint is a small synovial joint between a small oval facet on the medial surface of the acromion and a similar facet on the acromial end of the clavicle. It allows movement in the anteroposterior and vertical planes together with some axial rotation.

The acromioclavicular joint is surrounded by a joint capsule and is reinforced by two ligaments. (1)

Ligaments of the Acromioclavicular Joint

The **acromioclavicular ligament** is a fibrous band, extending from the acromion to the clavicle that strengthens the AC joint superiorly. However, the integrity of the joint is maintained by extrinsic ligaments, distant from the joint itself. The *coracoclavicular ligament* is a strong pair of bands that unite the coracoid process of the scapula to the clavicle, anchoring the clavicle to the coracoid process. The coracoclavicular ligament consists of two ligaments, the conoid and trapezoid ligaments, which are often separated by a bursa. The vertical **conoid ligament** is an inverted triangle (cone), which has its apex inferiorly where it is attached to the root of the coracoid process. Its wide attachment (base of the triangle) is to the conoid tubercle on the inferior surface of the clavicle. The nearly horizontal **trapezoid ligament** is attached to the superior surface of the coracoids process and extends laterally to the trapezoid line on the inferior surface of the clavicle. In addition to augmenting the AC joint, the coracoclavicular ligament

provides the means by which the scapula and the free limb are (passively) suspended from the clavicular strut. (4)

Scapulothoracic joint

The scapulothoracic joint is considered to be a functional joint rather than an anatomical joint. The joint surfaces are the anterior surface of the scapula and the posterior surface of the thorax. (1)

The motions that occur at the scapulothoracic joint are caused by the independent or combined motions of the sternoclavicular and acromioclavicular joints. These motions include scapular elevation-depression, upward-downward rotation, anterior-posterior tilting, and protraction-retraction. (5)

Glenohumeral joint

The **glenohumeral joint** is a synovial ball and socket articulation between the head of the humerus and the glenoid cavity of the scapula. It is multiaxial with a wide range of movements provided at the cost of skeletal stability. (1)

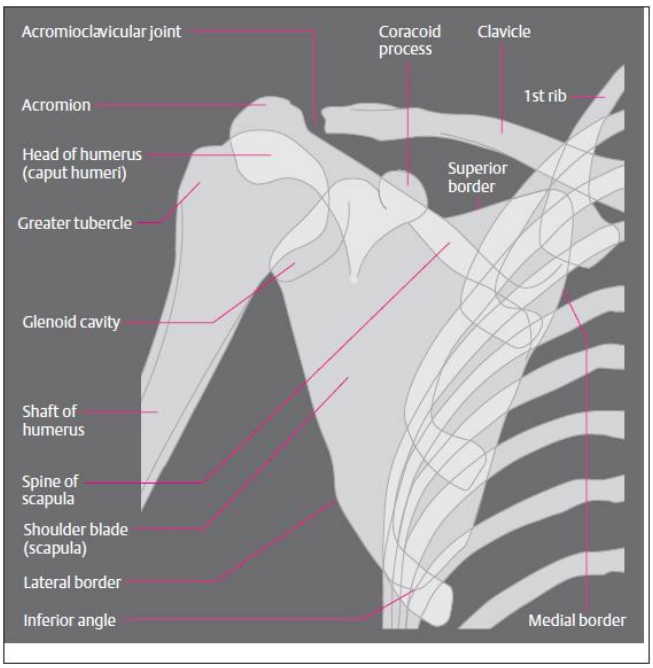

Figure 1: Simplified tracing of a radiographic image, anterior view

The large, round *humeral head* articulates with the relatively shallow *glenoid cavity* of the scapula which is deepened slightly but effectively by the ring like, fibrocartilaginous **glenoid labrum**. Both articular surfaces are covered with hyaline cartilage. The glenoid cavity accepts more than a third of the humeral head, which is held in the cavity by the tonus of the musculotendinous rotator cuff muscles. (4)

Movements of the joint include flexion, extension, abduction, adduction, medial rotation, lateral rotation, and circumduction. (1)

Ligaments of the Glenohumeral Joint

The glenohumeral ligament, which strengthen the anterior aspect of the joint capsule of the joint, and the coracohumeral ligament, which strengthens the capsule superiorly, are intrinsic ligaments – that is, part of the fibrous layer of the joint capsule. The **glenohumeral ligaments** are three fibrous bands, evident only on the internal aspect of the capsule, that reinforce the anterior part of the joint capsule. These ligaments radiate laterally and inferiorly from the glenoid labrum at the supraglenoid tubercle of the scapula and blend distally with the fibrous layer of the capsule as it attaches to the anatomical neck of the humerus. The **coracohumeral ligament** is a strong broad band that passes from the base of the coracoid process to the anterior aspect of the greater tubercle of the humerus. The *transverse humeral ligament* is a broad fibrous band that runs more or less obliquely from the greater to the lesser tubercle of the humerus, bridging over the intratubercular groove. The ligament converts the groove into a canal, which holds the synovial sheath and the tendon of the biceps brachii in place during movements of the glenohumeral joint. (4)

The **coracoacromial arch** is an extrinsic, protective structure formed by the smooth inferior aspect of the *acromion* and the *coracoid process* of the scapula, with the **coracoacromial ligament** spanning between them. This osteoligamentous structure forms a protective arch that overlies the humeral head, preventing its superior displacement from the glenoid cavity. The coracoacromial arch is so strong that a forceful superior thrust of the humerus will not fracture it; the humeral shaft or clavicle fractures first. Transmitting force superiorly along the humerus (e.g., when standing at a desk and partly supporting the body with outstretched limbs), the humeral head presses against the coracoacromial arch. The supraspinatus muscle passes under this arch and lies deep to the deltoid as its tendon blends with the joint capsule of the glenohumeral joint as part of the rotator cuff. Movement of the supraspinatus tendon, passing to the greater tubercle of the humerus, is facilitated as it passes under the arch by the *subacromial bursa*, which lies between the arch superiorly and the tendon and tubercle inferiorly. (4)

Muscles active during scapular movements

Movement	Shoulder muscles	Scapular muscles
Full flexion (up to 180°)	*Flexors:* Anterior Deltoid Biceps Pectoralis major, upper Coracobrachialis *Lateral rotators:* Infraspinatus Teres minor Posterior Deltoid	*Abductor:* Serratus anterior *Lateral rotators:* Serratus anterior Trapezius
Full abduction (to 180°)	*Abductors:* Deltoid Supraspinatus Biceps, long head *Lateral rotators:* Infraspinatus Teres minor Posterior Deltoid	*Adductor:* Trapezius, acting to stabilize scapula in adduction *Lateral rotators:* Trapezius Serratus anterior
Full extension (to 45°)	*Extensors:* Posterior Deltoid Teres major Latissimus dorsi Triceps, long head	*Adductors, medial rotators and elevators:* Rhomboids Levator scapulae *Anterior tilt of scapula by:* Pectoralis minor
Full adduction to side against resistance	*Adductors:* Pectoralis major Teres major Latissimus dorsi Triceps, long head	*Adductors:* Rhomboids Trapezius

Table 1

(6)

2.2 Kinesiology of the upper extremity

Both upper extremities constitute one common organ working in one closed mechanic chain, and also in different virtual functional chains organized in the brain. Every upper extremity can work separately, oriented in grasping and manipulation of objects. (2)

The purpose of the shoulder and the entire upper extremity is to allow the hand to be placed in various positions to accomplish the multitude of tasks it is capable of performing. The shoulder, or glenohumeral joint, is the most mobile joint in the body and is capable of a great deal of motion. (7)

One extremity is dominant and the other one is subdominant. Flexion function is more expressed than extension, serving to bring objects near to the body or to embrace them. This is evident in babies bringing all objects to the mouth. (2)

The coracoid process of the acromion, together with the coracoacromial ligament, limit upward mobility and at the same time secure the head of the humerus in the glenoid cavity. When the arm is lifted above the horizontal line, the scapula, and so the glenoid cavity, must rotate. The movements at the shoulder joint take place in three axes, as in every ball-and-socket joint. The muscular action occurs chiefly in the musculotendinous cuff (rotator cuff, i.e. supraspinatus, infraspinatus, subscapularis and teres minor muscles) and the deltoid muscle, the most important abductor of the upper arm. In addition, the anterior part of the deltoid (pars clavicularis) flexes the arm and the posterior part (pars scapularis) extends it. (8)

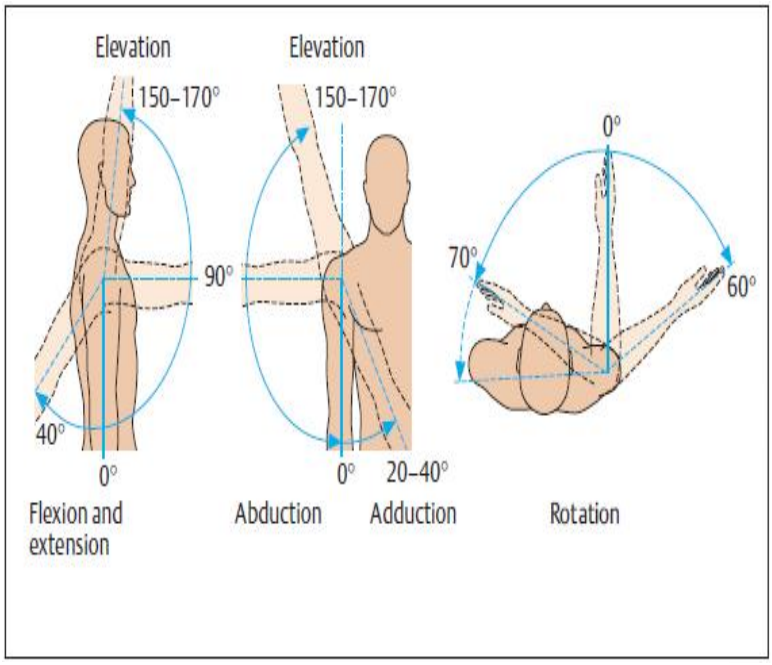

Figure 2: Movements of the shoulder joint

The muscles of the musculotendinous cuff all have their origin on the scapula and are inserted into the greater or lesser tubercle of the humerus. While the teres minor and the infraspinatus muscles rotate the upper arm outward (external rotation), the subscapularis muscle is an important internal rotator. Finally, the supraspinatus muscle takes part in abduction, especially its initiation. The pectoralis major, the latissimus dorsi, and the teres major muscles adduct the arm. (pull it towards the trunk) and to varying extents rotate it externally or internally. (8)

Upper extremities are steadily engaged in the daily living activity, during both occupational and leisure activities, and serve also as an indispensable communication instrument completing the rational verbal information with emotional accent and enabling also the nonverbal direct contact information in the physiotherapy in the treatment as well as in the diagnostics. (2)

2.3 Biomechanics of the upper extremity

The upper limb, with its mobile shoulder, it's extensible and folding member, the arm and forearm and its terminal working tool the hand, is versatile and has a large range of movement allowing the manipulation of objects. Loss of function in any of the upper limb joints translates into reduced function of the hand, which could hamper such daily activities as eating, dressing, and personal hygiene. (9)

Loads on the shoulder joint

Because the articulations of the shoulder girdle are interconnected, they function to some extent as a unit in bearing loads and absorbing shock. However, because the glenohumeral joint provides direct mechanical support of the arm, it sustains a much greater load than the other shoulder joints. (3)

The glenohumeral joint is loaded even in posture, where the arm hangs down without any load in the hand. The tension of the abductor muscles balances the downward pointing gravitational force of the arm. As tensile force of the abductors is not perpendicularly aligned, a component of this force points on the glenoid cavity. (10)

Scapulohumeral rhythm

Although a limited amount of glenohumeral motion may occur while the other shoulder articulations remain stabilized, movement of the humerus more commonly involves some movement at all three shoulder joints. As the arm is elevated in both abduction and flexion, rotation of the scapula accounts for a part of the total humeral range of motion. Although the absolute positions of the humerus and scapula vary due to anatomical variations among individuals, a general pattern persists. (3)

Scapulohumeral rhythm is a concept that further describes the movement relationship between the shoulder girdle and shoulder joint. The first 30 degrees of shoulder joint motion is pure shoulder joint motion. However, after that, for every 2 degrees of shoulder flexion or abduction that occurs, the scapula must upwardly rotate 1 degree. This 2:1 ratio is known as scapulohumeral rhythm. It is possible to demonstrate that the first part of shoulder joint motion occurs only at the shoulder joint, but further motion must be accompanied by shoulder girdle motion. With a person in the anatomical position, stabilize the scapula by putting the heel of your hand against the axillary border to prevent rotation of the scapula. Instruct the person to abduct the shoulder

joint. Notice that the individual is only able to abduct a short distance before shoulder joint motion is impaired. (7)

Scapulohumeral rhythm enables a much greater range of motion at the shoulder than if the scapula was fixed. During the first 90° of arm elevation (in sagittal, frontal, or diagonal planes), the clavicle is also elevated through approximately 35° to 45° of motion at the sternoclavicular joint. Rotation at the acromioclavicular joint occurs during the first 30° of humeral elevation and again as the arm is moved from 135° to maximum elevation. (3)

2.4 Types of fractures

A fracture describes any loss of continuity in the substance if a bone; this may range from a hair line crack to a massive disruption of a bone. In a closed fracture the skin overlying the break is intact, if there are any injuries to the skin these are superficial and not related to the fracture. In an open (formally called compound) fracture there is a wound connecting the broken ends of the bone with the outside air. In some cases the broken end of bone may protrude through the skin. However, broken ends of bone may penetrate the skin from inside and not be superficially visible. This is why even small wounds around a fracture site must be treated with extreme suspicion as they may indicate that a fracture is open. Outside trauma may also cause a wound which is continuous with a fracture, if there is any communication between the broken bone and the surface there is the potential for infection to enter the bone. This may lead to osteomyelitis which can be very difficult to eliminate (11)

Fracture line

A fracture line is caused part way through the bone on the opposite side to the cause of traumatic forces. (11)

The fracture line may traverse the whole diameter of the bone or minor may cause a break in the continuity of the normal cortical outline. (12)

Greenstick fractures

Greenstick fractures occur in children as their bones are not as brittle as adults. (11)

In children bone tends to be more flexible, so a greenstick fracture may occur with bending on one side with a break of the cortex on the other side. The bone might also buckle without an actual break. (12)

Simple fractures

Simple fractures are uncomplicated and closed and are described by the orientation of the fracture line seen. In simple transverse fracture the break runs at a right angle to the shaft of the bone or has an angle of less than 30°. If the angle is more than 30° the fracture is described as oblique. A simple spiral fracture spirals around the shaft of the bone. (11)

Comminuted fractures

In contrast to simple fractures, a complicated fracture is one which involves important soft tissue damage such as damage or compression of blood vessels, nerves or internal organs. Comminuted fractures are also described as mulitfragmentary and are usually caused by high energy trauma, such as road traffic accident or high falls. Comminution describes a fracture with more than two fragments, in severe cases there may be multiple pieces of bone. These fractures are often associated with significant soft tissue injuries, can be difficult to reduce and heal slowly. (11)

Crush/compression fractures

Crush fractures occur as a result of compression forces; these may involve vertebral bodies or heels. (11)

Avulsion fractures

Avulsion fractures are caused by tractional forces such as those generated by sudden muscular contractions when a tendon or ligament may tear off a fragment of the bone. (11)

An avulsion fracture occurs when a fragment of bone becomes detached from the site of the ligament or tendon insertion. (12)

Impacted fractures

Impacted fractures occur when one bone fragment is driven into another. (11)

In an impacted fracture, the fragments are compressed into each other, with no apparent visible fracture line. (12)

Depressed fractures

If the skull is struck by a blunt object, such as a hammer, a piece of bone may be forced down into the brain tissue; this is termed a depressed fracture. (11)

Displacement fractures

Displacement is when the bone ends have shifted relative to one another. This is important as soft tissues may be damaged or the fracture may become open. For example, a displaced vertebral fracture may damage the spinal cord resulting in complete loss of motor and sensory function below the level of the lesion. (11)

Pathological fractures

The capacity of bone to resist stress depends on maintaining the quantity, quality, and normal architecture of the bone. There are pathological conditions that can adversely affect one or more of these factors, creating a situation in which bone is unable to withstand a moderate force that normally would be tolerated easily. When fractures occur in such situations it is called a pathological fracture, meaning that some morbid process has weakened the bone to the point that it cannot resist relatively normal biomechanical stress. (13)

A pathological fracture is a fracture through a diseased bone, often after trivial trauma, e.g. Paget's disease, osteoporosis or tumor. (12)

Stress/fatigue fracture and hairline fractures

Stress or fatigue fracture results from chronic repetitive minor trauma. Susceptible areas include the second and third metatarsals (March fracture), proximal tibial shaft, fibula and the femoral shaft (long distance runners and ballet dancers) (12)

Hairline fractures are caused by minimal trauma or repeated stress, there is no displacement of the bone ends. (11)

A stress fracture is a hairline break in bone that occurs in the absence of acute trauma, is clinically sympthomatic, and is detectable by X-rays or bone scans. The typical fine hairline fracture may be undetectable by X-rays or bone scans for three or four weeks after pain is evident. (14)

Proximal humerus fractures

Fractures of the proximal humerus can involve the surgical and/or the tuberosities. Isolated greater-tuberosity fractures can often be associated with anterior shoulder dislocation, and displaced tuberosity fragments should be reduced and fixed. Isolated lesser-tuberosity fractures are uncommon and may occur with posterior shoulder dislocations. Large lesser-tuberosity fragments may require open reduction and fixation if they are significantly displaced. (15)

Most injuries of the proximal end of the humerus are *fractures of the surgical neck*. These injuries are especially common in elderly people with osteoporosis, whose demineralized bones are brittle. Humeral fractures are often resulting in one fragment being driven into the spongy bone of the other fragment (impacted fracture). The injuries usually result from a minor fall on the hand, with the force being transmitted up the forearm bones of the extended limb. Because impaction of the fragments, the fracture site is sometimes stable and the person is able to move the arm passively with little pain. (4)

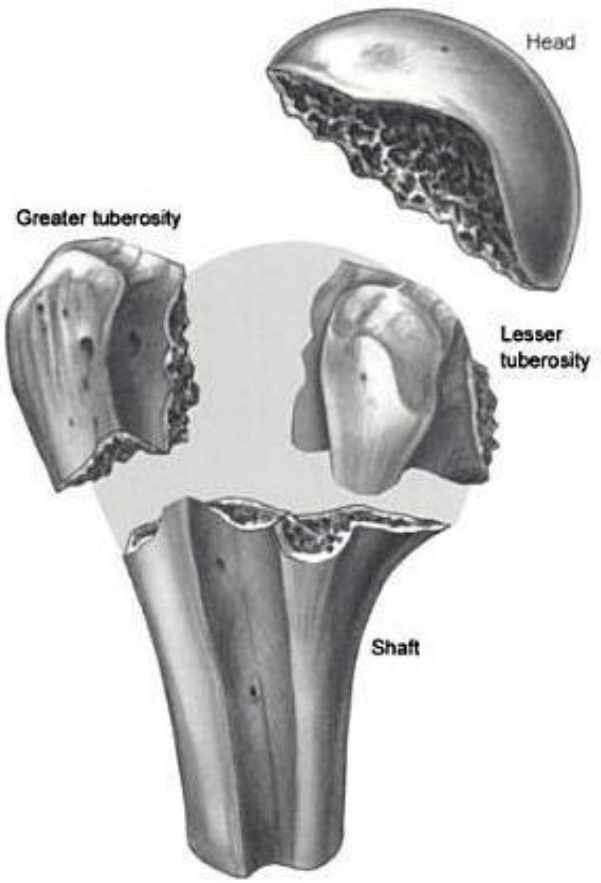

Figure 3: Drawing of pathoanatomy of proximal humerus fractures

Proximal humerus fractures most commonly result from a fall onto an outstretched hand from a standing position. The fracture results from an indirect force that is transmitted to the proximal humerus as the patient attempts to cushion the fall with the outstretched arm. Two alternative injury mechanisms include: (1) a direct lateral blow to the shoulder, or (2) an axial load transmitted through the elbow. (16)

The Neer classification

The classification proposed by Neer remains the worldwide standard for evaluation and discussion of proximal humerus fractures. (17)

Neer proposed his classification of proximal humeral fractures in 1970, and since then it has become the most widely used system in clinical practice. This system is based on the anatomic relations of the four major anatomic segments: articular segment, greater tuberosity, lesser tuberosity, and the proximal shaft, beginning at the level of the surgical neck. Knowledge of the rotator cuff insertions and the effects of the muscular deforming forces on the four segments is essential to understanding this classification system. Fracture types are based on the presence of displacement of one or more of the four segments. For a segment to be considered displaced, it must be either displaced more that 1 cm or angulated more that 45 degrees from its anatomical position. (18)

2.5 Types of rehabilitation

In order to heal the fracture, the ends must be immobilized by either plaster casts or internal or external fixation. In first aid situations, splints may reduce bleeding, further bone or soft tissue injury, pain and nerve or blood vessel compression. Good levels of immobilization reduce the amount of excess callus formed and improve the rate of bone healing. If the fracture is not immobilized this may result in formation of a pseudoarthrosis. (11)

Much of the literature concerning treatment of proximal humeral fractures has documented the results of various treatment methods, including wiring, plating, intramedullary nailing, and hemiarthroplasty, with surgeons usually claiming good results. Very few comparative studies of different treatment methods have been undertaken, however, and thus the indications for treatment of different fractures remain confused. In recent years there has been a realization that the majority of proximal humeral fractures occur in elderly patients and that non-operative management may give equivalent or better results than surgery in this group of patients. (19)

Over the past decade, there has been ongoing controversy about relative merits of operative versus non-operative treatment for proximal humerus fractures, as well as uncertainty about whether better results are achieved with internal fixation or hemiarthroplasty. (17)

Fractures of the proximal humerus are potentially complex injuries that can be challenging to diagnose and treat. A comprehensive evalutation of the entire shoulder girdle is an essential component of the management of these injuries. Imaging of the proximal humerus can be difficult. An accurate radiographic evaluation must be obtained, however. Classification systems have evolved over time, and their ability to reliably predict outcome and guide treatment has greatly improved. (16)

Surgical treatment

Proximal humerus fractures that require surgical treatment account for only 20% of fractures in this region because most are satisfactorily managed with non-operative methods. A small percentage of the fractures involve severe comminution or occur in the setting of poor quality bone, which precludes stable fixation and thus requires endoprosthetic treatment. These cases can be very technically challenging, owing to loss of available anatomic landmarks. (20)

There are two general methods of operative fracture fixation: internal fixation and external fixation. Internal fixation involves placement of screws, plate wires, or intramedullary rods through open means, across the fracture to impart stability. External fixation implies the use of percutaneously placed pins and wires attached to external bars or rings to stabilize the fracture. (21)

Internal fixation

The main benefit of internal fixation is that it provides stable fixation, allowing postoperative mobilization. Healing can occur via primary or secondary bone healing, depending on the stability obtained at surgery. It is important to understand that the plate fixation can be used to obtain both absolute and relative stability, depending on how it is applied. Internal fixation methods include plates and screws, Kirschner wires, intramedullary nails and tension-band constructs. (21)

External fixation

External fixation is the percutaneous placement, above and below a fracture, of wires or half pins that are connected to bars and tubes to provide stability. The advantages of external fixation include minimal soft tissue trauma, avoidance of hardware in a contaminated wound, rapidity of application, and modularity to adapt to many injury patterns. An external fixator can be used for temporary or long-term fixation; it is a good option in situations where the risk of infection is high or the soft tissue is compromised. The disadvantages include the cumbersome nature of the fixator, complications related to the pin sites (infection, loosening), and carrying degrees of stability, which can result in malunion or nonunion. External fixators can vary from very simple frames consisting of two pins connected by two bars to very complex frames with wires and rings that have the ability to correct deformities or lengthen bones. (21)

Hemiarthroplasty

Proximal humeral replacement is a useful surgical technique for acute displaced fractures of the proximal humerus. The indication for placement of a prosthesis are (a) 4-part fractures and fracture dislocations, (b) head-splitting fractures, (c) impression fractures involving more than 40% of the articular surface, and (d) selected 3-part fractures in older patients with osteoporotic bone. (15)

Prosthetic replacement should be utilized in older patients in which the head-splitting fracture is a component of a more complex humerus fracture; that is a four-part fracture. (16)

The goal of surgery is to anatomically reconstruct the glenohumeral joint with restoration of humeral length, placement of appropriate prosthetic retroversion and secure tuberosity fixation. (22)

The contraindications for proximal humeral replacement are active soft-tissue infection, chronic osteomyelitis, and paralysis of the rotator cuff muscles. (15)

Conservative treatment

The majority of humeral fractures are minimally displaced. These stable fractures may be managed with only brief immobilization in a sling. (17)

Fractures that are treated non-operatively should be stable enough to allow early functional use and be minimally displaced. At the time of the initial evaluation, the arm should be examined to ensure that the proximal part of the humerus could be moved, with motion occurring at the shoulder joint and not the fracture site. There should not be a significant posterior or superior displacement of the greater tuberosity; uncorrected displacement of the tuberosities has adverse effects upon rotator cuff function, whereas surgical neck malunion may affect range of motion. (17)

Nondisplaced and minimally displaced fractures are treated with a sling for comfort. Elbow, wrist and hand exercises are encouraged during the initial immobilization period. If the fracture is stable, range-of-motion exercises may be started within 10 days, if the pain is tolerable. The physician can evaluate the fracture for gross stability by manipulation of the elbow and forearm with gentle rotation while palpating the proximal humerus with the other hand. If the entire humerus appears to move as a unit, then the fracture is stable, and gentle passive range-of-motion exercises may be started. (22)

<u>Splints and casts</u>

Splints and casts support and immobilize the injured extremity and thereby reduce pain, prevent further injury of tissues in proximity to a fracture, and maintain alignment. Splinting and casting are also used postoperatively to reduce swelling, maintain

surrounding joints in a position of function, and provide additional stabilization when fracture fixation is tenuous. Splinting and casting are accomplished with plaster or synthetic materials such as fiberglass. Splints differ from casts in that they are not circumferential and thus allow swelling of the extremity with less increase of pressure. Casts are circumferential and swelling within the cast increases pressure, potentially resulting in increased compartment pressures or pressure sores. Casts tend to immobilize an extremity more completely than splints. (21)

2.6 Epidemiology and etiology

Proximal humerus fractures are relatively common, representing 4 to 5% of all fractures. They are considered to be an osteoporosis-related fracture based on an increased incidence in elderly women and this location in metaphyseal bone. Approximately 75% of proximal humerus fractures occur in elderly postmenopausal women, and they are most commonly associated with simple falls. Like other osteoporosis-related fractures, a unipolar age distribution exists, with the highest incidence occurring in octogenarian woman. (16)

Nearly three fourths of all proximal humerus fractures occur in patients older than 60 years, and they generally occur as a result of low-energy trauma, such as fall from standing height. A majority of these injuries are nondisplaced or minimally displaced and have a good overall prognosis with nonsurgical management. Specific risk factors associated with the development of proximal humerus fractures in elderly include low bone density, impaired vision and balance, lack of hormone replacement therapy, previous fracture, three or more chronic illnesses, and smoking. (22)

A large epidemiologic study from Sweden demonstrated a steady and significant increase of proximal humerus fractures over the last 30 years. Other investigators have reported similar results and have partially attributed these findings to the increased average life span. All epidemiologic data confirm that fractures of the proximal humerus are primarily an osteoporosis injury, as our population ages, these fractures will represent an increasingly significant socioeconomic problem and source of morbidity in the elderly population. (16)

In contradistinction to the elderly, younger patients generally sustain proximal humerus fractures during high-energy situations such as motor vehicle collisions, seizures, or electrical shock. These injuries tend to me more severe regarding soft tissue compromise and fracture displacement requiring operative intervention. (22)

3. Special Part – Case Study.

3.1 Methodology

My case study took place at Centrum Léčby Pohybového Aparátu Vysočany, Prague, from 08.02.10 until 19.02.10. The clinic specializes in post adult orthopedic surgery and sports traumatology rehabilitation. The clinic offers a wide range of therapeutical techniques and methods, including electrotherapy, hydrotherapy and a fully equipped fitness room. In cooperation with the rehabilitation clinic is an orthopedic surgery clinic.

My study was supervised by PhDr. Edwin Mahr PhD. and all examinations and therapeutical procedures were done in cooperation with him.

My patient was informed from the beginning and the work has been approved by the Ethics Committee of the Faculty of Physical Education and Sport at Charles University, Prague.

3.2 Anamnesis

Performed 10.02.10.

Name: M.V. Female

Height: 155cm

Weight: 43 kg

BMI: 17.9

Temperature: N/A

BP:120/70

BF: 24/min

DOB: 08.06.1940

Diagnosis:

Status post fracture of left proximal humerus

Chief complaint:

Shooting pain radiating down the whole left arm, and sometimes the pain is electrical and accompanied cramp like tendencies down the left upper extremity and shoulder. Pain occurs during overhead movements, especially. Patient has difficulties in performing movements, especially those involving flexion and abduction. On a painscale from 1-10, where 1 is no pain and 10 is unbearable pain she numbers it 8 at its worst. She also complains of some pain at rest but pain increases with movement, especially in the shoulder joint.

History of present problem

She fell down the stairs at home at around 06.00 AM, 29.12.09. Later the same day she went to her medical doctor with pain in left shoulder. She was tested and doctor found pain only in the left upper extremity by palpation. Pain was not noted anywhere else. No head or neck trauma was noted and patient was described as cooperative, well oriented and with full consciousness. No loss of consciousness was noted during the fall.

Psychosocial history:

Work: Does not work. Never worked due to her physical condition

Hobbies: Reading. Never did any sports, even in youth

Living conditions: Living alone with her dog on the 3rd floor in a building without an elevator

Married: No

Children: 1, daughter

Associated problems: Patient manages most ADL's herself, but complains of pain when doing gross movements, especially over head movements.

Personal/Medical history

Diseases:

Asthma Bronchialis

High blood pressure (controlled by medications)

Osteoporosis

Operations: None

Gynecological examination:

Normal menstruation cycle until menopause.

One pregnancy, no complications.

Family history:

Father: Died of old age in 1999. No known diseases.

Mother: Died of old age in 2001. Cox arthritis in both hips

Brother: Still alive. Scoliosis.

Medications:

Asthma medication, Berodual

High blood pressure, Type unknown

Endocrinological, Name unknown

Smoke: yes, 10-14 cigarettes a day

Alcohol: on occasion

Drugs: No

Previous rehabilitation:

Patient did not have any previous rehabilitation except for keeping the arm in a Desault loop when in standing position and with pain. She was wearing the loop from 29.19.09 to 26.01.10. The fracture was treated conservatively.

Health document extract:

Patient visited medical doctor 29.12.09 in the afternoon, after a fall the same morning. The patient complains of pain in her left shoulder. Patient was tested for pain by palpation, and no pain was found in chest, head or neck. No other traumas were noted in the head or neck. Patient was noted as cooperative, well oriented and with full consciousness during the testing. Patient had pain when testing active and passive movement. An x-ray examination was performed and a slight dislocation of proximal shaft of left humerus, ad latus, was observed. The fracture was treated conservatively with a Desault loop until 26.01.10, when a new x-ray examination was performed and findings showed good bone healing, which was sufficient enough to stop wearing the Desault loop.

Indications for rehabilitation:

Patient should undergo rehabilitation of fracture in proximal humerus, including increasing ROM and assist in better performance of ADL's

Differential considerations:

As the patient's problems clearly result from a trauma, a differential consideration is unnecessary. Any neurological damage should however be examined and excluded before therapy starts.

3.3 Initial Kinesiological Examination:

Examination was performed 10.02.10.

Postural examination

Anterior:

- External rotation of feet
- Physiological arches of feet (both longitudinal and transversal)
- External rotation of knee
- Semiflexion and small internal rotation of left arm
- Head rotated to the left side
- Right shoulder elevated

Posterior:

- Smaller stance
- Brachioradial triangle bigger on right side
- Sinister convex in lumbar spine
- Dexter convex in thoracic spine
- Internal rotation of lower angle of scapula, left side
- External rotation of lower angle of scapula right side
- Scapula alata noted on right side, small
- Elevation of right shoulder

Lateral:

- Semiflexed elbow
- Protracted shoulders
- Forward head position

Pelvis examination

Crista: 0.5 cm higher on right side

Spina iliaca anterior superior: 0.5 cm higher on right side

Spina iliaca posterior superior: 0.5 cm higher on right side

Balance and Proprioceptive Tests

Vele: Negative

Romberg 1: Negative

Romberg 2: Negative

Romberg 3: Negative, but some instability at end of test period

Trendelenburg left leg: performed with great rotation, accompanied with great pain in left shoulder. Positive.

Trendelenburg right leg: Positive

Functional movements:

Both hands to head: Manages to touch head with both hands. Right hand with no problem or pain. Pain occurs when attempting the movement with the left hand. Patient is able to reach the head with maximal elbow flexion and flexion and lateral flexion of neck, however this is painful

Hands to back from below: Manages to reach middle of the back with no pain of the right arm. Barely reaching low back with left arm. Painful.

Hands to back from above: Manages to reach back with no problem with the right hand. Barely reaching upper back with left hand under tremendous pain.

Hands over head: No problem with the right hand. Left arm reaching level of shoulder.

Sensation Examination

Superficial skin sensation: Sensation tested on the whole upper extremity, neck and upper back. Sensation was normal.

Steroagnosia: Patient was tested in the palm with different digit tracing movements. Patient had no problems differentiating these.

Deep sensation movement sense: Normal

Breathing, performed in lying position.

Type: Upper thoracic breathing, accompanied with accessory muscles.

Frequency: 24 breaths per minute

Notes: Patient has short, insufficient breaths. Breathing pattern is better when lying, than in sitting position, but an upper thoracic breathing is present while lying.

ROM (6)

	Left upper extremity		**Right upper extremity**	
Movement	**Active**	**Passive**	**Active**	**Passive**
Shoulder Flexion	70°*	80°*	130°	130°
Shoulder Extension	20°	20°	45°	45°
Shoulder ADD	0°	0°	0°	0°
Shoulder ABD	40°*	50°*	110°	120°
Shoulder ER	30°X*	35°X*	80°	85°
Shoulder IR	15°X*	20°X*	65°	70°
Elbow Flexion	130°	150°	150°	150°
Elbow Extension	0°	0°	-5°	-5°
Elbow Supination	90°	90°	90°	90°
Elbow Pronation	90°	90°	90°	90°
Wrist Dorsiflexion	50°	80°	70°	85°
Wrist Palmarflexion	80°	80°	80°	80°
Wrist Radial duction	30°	30°	30°	30°
Wrist Ulnar duction	25°	25°	25°	25°

Table 2

X= Measured in position of 40° ABD

*= Movement accompanied with pain

Joint play (23)

Explanation to tables:

O= No blockage X= Blockage XX= Blockage with pain XXX= Impossible to perform due to pain

Interphalangeal joints (proximal and distal):

Interphalangeal joint, right upper extremity					
Digit	**1st**	**2nd**	**3rd**	**4th**	**5th**
Dorsopalmar	O	O	O	O	O
Laterolateral	O	O	O	O	O
Rotation	O	O	O	O	O
Lateral	O	O	O	O	O
Interphalangeal joint, left upper extremity					
Digit	**1st**	**2nd**	**3rd**	**4th**	**5th**
Dorsopalmar	O	O	O	O	O
Laterolateral	O	O	O	O	O
Rotation	O	O	O	O	O
Lateral	O	O	O	O	O

Table 3

Metacarpophalangeal joints 2-5th digit

Metocarpophalangeal joints 2-5th digit, right upper extremity				
Digits	**2nd**	**3rd**	**4th**	**5th**
Dorsopalmar	O	O	O	O
Laterolateral	O	O	O	O
Rotation	O	O	O	O
Metocarpophalangeal joints 2-5th digit, left upper extremity				
Digits	**2nd**	**3rd**	**4th**	**5th**
Dorsopalmar	O	O	O	O
Laterolateral	O	O	O	O
Rotation	O	O	O	O

Table 4

Metacarpophalangeal joint of the thumb

Metacarpophalangeal joint of the thumb		
	Right thumb	**Left thumb**
Dorsopalmar	O	O

Table 5

Intercarpal joints

Intercarpal joints		
	Right side	**Left side**
Palmar	O	O
Palmar, lateral segments	O	O
Pisiform	O	O
Schapoid	O	O
Capitate	O	O
One carpal to the other	O	O

Table 6

Radiocarpal joint

Radiocarpal joint		
	Right side	**Left side**
Dorsal direction	O	O
Dorsal direction, radial side	O	O
Dorsal direction, ulnar side	O	O
Proximal row, radial direction	O	O

Table 7

Distal/proximal radioulnar joint

Distal radioulnar joint		
	Right side	**Left side**
Shearing	O	O
Head of radius, ventral direction	O	X

Table 8

Elbow joint

Elbow joint		
	Right side	**Left side**
Radial	O	X
Ulnar	O	X

Table 9

Shoulder joint

Shoulder joint		
	Right side	**Left side**
Ventral	O	X
Dorsal	O	XX
Caudal	O	XX
Lateral	O	XXX

Table 10

Scapular movements

Scapular movements		
	Right side	**Left side**
Movement of scapula against trunk	O	X
Abduction with elevation	O	X

Table 11

Sternoclavicular joint

Sternoclavicular joint		
	Right side	**Left side**
Springing distraction	O	O

Table 12

Muscle strength test (6)

	Right side	Left side
Biceps brachii	4+	3+(*)
Triceps brachii	4+	3+(*)
Brachioradialis	4	3+(*)
Supinator	4	4
Pronator teres/quadratus	4	3+
Coracobrachialis	4	3+
Deltoid, whole muscle	4	3+(*)
Deltoid, anterior	4	3+(*)
Deltoid, posterior	4	3+(*)

Table 13

(*) = with pain

Examination against isometric resistance of the rotator cuff muscles of the shoulder according to Cyriax, (23)

	Right side	Left side
Against abduction	No pain	No pain
Against external rotation	No pain	Pain
Against internal rotation	No pain	Pain
Against raising of semi flexed arm	No pain	Pain

Table 14

Palpation of muscles

	Right side			Left side		
	Tonus	**Pain**	**Trg. point**	**Tonus**	**Pain**	**Trg.point**
Biceps brachii	Hypo	No	No	Hypo	No	No
Triceps brachii	Hypo	No	No	Hypo	No	No
Deltoid	Normal	No	No	Hyper	Slight	No
Trapezius	Normal	No	No	Hyper	Yes	Yes
Supraspinatus	Normal	No	No	Hyper	Yes	Yes
Infraspinatus	Normal	No	No	Hyper	Yes	Yes
Subscapularis	Normal	No	No	Hyper	Yes	Yes
Paravertebral	Hyper	Yes	Yes	Hyper	Yes	Yes

Table 15

Scale test

Right side	Left side	
20 kg	23kg	
	Total	43 kg

Table 16

Anthropometry performed in lying position

	Right upper extremity	Left upper extremity
Upper arm circumference	19 cm	18 cm
Forearm circumference	20 cm	19 cm
Upper arm length	31 cm	30 cm
Forearm length	22 cm	23 cm
Whole arm length	70 cm	68 cm

Table 17

Conclusion

In the postural examination a couple of important findings were noted. The patient had semiflexion and internal rotation of her left arm, which might be a protective mechanism, not to load her affected upper extremity too much. Her right shoulder was also elevated, possibly for the same reason. This would also explain her shifted trunk, evident by the bigger brachioradial triangle on the right side and rotation of her head to the left. On examination of her back, scoliosis was detected with a sinister convex in the lumbar area and a dexter convex on the thoracic area; a possible compensation for her body shift. Her spinous processes were quite visible due to her low bodyweight, so the curvatures were not big, but easily seen on the postural examination. It is, however, important to note in a holistic view of the patient. Looking at the scapulae, her left scapula was in internal rotation of lower angle, and right one was in external rotation. This supports the theory of a body shift.

When looking at the position of the pelvis, one could clearly see a tendency of a higher right side in all landmarks measured, but any different lower limb length was not seen, again supporting the theory of a body shift to decrease pain. When looking at the scale

examination, one could see a greater loading on the left leg, but not enough to prove any dysbalance in loading, but one could note the tendency.

When considering the neurological examination only the Trendelenburg test was positive. On the left side she was rotating her body and complained about pain in her left shoulder. The actual result of the test is not as important, as the patient is aged, but it should be noted that patient experiences pain, even when moving body parts far from the trauma site. This is important when thinking about performance of ADL's.

Some functional movements were also included in the initial examination for this reason. She showed great limitation in ROM on her left side, especially during overhead movements and rotation of the shoulder joints. She also expressed that this was limiting in her everyday life, as some ADL's were difficult to perform due to this fact.

Superficial sensation and movement sense were included to exclude any neurological damage in her upper extremity. She expressed good sensation and movement sense in her affected lower extremity, and when compared to the non affected side, no differences were noted.

As the patient mentioned asthma in her diagnosis, and by aspection one could see a faulty movement pattern, breathing examination was included in the examination. This showed a marked upper thoracic breathing, with an excessive use of accessory muscles. Her breathing frequency was also relatively high with 24 breaths per minute. This might be explained with her asthma diagnosis. Thinking in a broader picture her tensed shoulder and upper back area is not necessarily entirely caused by her trauma, but could also be as a result of a long term faulty breathing pattern. The breathing therapy could therefore be assistive in reaching better ROM and decrease pain in this patient.

One of the most important examinations in this patient, and a great indicator of the severity of the problem, is the measurement of the ROM. As expected, the patient showed a marked limitation of movement in the shoulder joint, with shoulder flexion, extension and adduction resulting in severely decreased ROM. Shoulder internal and external rotations were impossible to measure due to inability of the patient to reach the starting position because of pain. Shoulder flexion and abduction were also accompanied by pain. A small limitation of active elbow flexion was also noted. Active movements were more limited than passive movements, which could be an indicator of pain during muscle contraction. This is discussed into more detail under examination of

muscle strength, movement against isometric resistance and palpation of muscle tonus and triggerpoints. Patients ROM of the non-affected upper extremity are noted as normal.

Another important indicator of the patient's problem is the examination of joint play. Patient had what could be considered a normal joint play in all articulations up to the elbow, where restricted joint play was found in ulnar and radial direction, and the head of radius was blocked. The shoulder showed limited joint play in all direction, ventral, dorsal, caudal and lateral. Acromioclavicular and sternoclavicular joints were tested, and no restrictions were found. Joint play was also tested in non-affected upper extremity, where no restrictions were found. Restriction in the elbow and shoulder joint might be explained by the fact that the patient was using a supportive sling in order for her fracture to heal, for a period of a month. The affected upper extremity was immobile in this period, which might have caused restriction in joint movement.

Based on findings in ROM and joint play examinations a limitation of testing muscle strength was done to include muscles in the shoulder and elbow area only. This was to save time and avoid too much stress on the patient's body. The examination showed decreased strength in most of the tested muscles on the affected side. Most noticeable in this examination is the weakness of the biceps brachii, triceps brachii, brachioradialis and the deltoid muscles. Patient also expressed that contracting muscles against resistance was painful. It is important to note that the patient had some strength in the affected upper extremity, despite her low grades. Compared to the non-affected side, the affected side has not a greatly reduced strength. One theory is that the muscle strength itself is not that bad, but the pain is a contributing factor for her low grades in muscle strength testing. Her restricted active motion, compared to the passive motion tested in the ROM examination supports this theory. Strength is however limited, and should be worked on if possible.

When examining contraction against isometric resistance of the rotator cuff muscles, the patient expressed pain in all directions on the left side, except abduction. Weakness was also noted in all directions, except raising of semiflexed arm. Taking into consideration her state, this is to be expected.

When palpating and examining individual muscles hypotonus were found in biceps and triceps brachii on both sides. Rotator cuff muscles were found in hypertonus with both

pain and triggerpoints on left side. On right side, rotator cuff was in normal tonus with no pain or triggerpoints. Paravertebral muscles were also found to be hypertonic on both sides, with triggerpoints throughout the whole spine.

Anthropometrics were done do exclude any structural changes after the trauma. Even though a difference of 2 centimeters was found in measuring the whole upper extremity, when left and right extremities were compared, one should think of the patient's arm position in slight semiflexion. Human error could therefore be the reason for different findings in this case. More interesting is the circumference results. Both upper arm and forearm has a greater circumference on the right, non-affected extremity. It is also interesting to note that circumference of forearms are greater that circumference of upper arms in both upper extremities. This may indicate the weakness as found in the muscle strength test, and since this includes the non-affected upper extremity as well it suggests that the lesser circumference of the upper arm was present also prior to the fracture. When we examine the result, one can also see the relatively low number, supported by my patient's body weight and BMI score.

3.4 Rehabilitation Plan:

Short-term rehabilitation plan:

- Reduce decreased joint play by manual techniques (23)
- Decrease hypertonus in rotator muscles of shoulder by PIR (23) and STT
- Reduce hypertonus and triggerpoint of upper back and neck using STT
- Education of breathing patterns
- Facilitate activation of upper extremity using PNF (23)

Long-term rehabilitation plan:

- Increase deep stabilization of shoulder girdle using sensomotoric training
- Increasing strength in upper extremity using Hold-Relax-Active movement technique of PNF (23)
- Educating patient in self therapy exercises to increase ROM in shoulder joint
- Exercising with propriomed and terrabands

3.5 Therapy progress

Day to day therapy

Date: 10.02.10 Time: 13:00

Status:

Subjective: Patient was under a lot of pain during this session, and complained of great pain during movements: flexion and abduction of shoulder.

Objective: Patient shows great limitation on flexion and abduction of shoulder. Together with subjective pain perception and functional movements, this is going to be tested for every therapy session to mark progress

Objective of today: First meeting with this patient today, and a lot of time was spent performing the examination. This lead decreased time spent on therapy due to physical discomfort.

Therapy proposal: According to findings found in the initial kinesiological examination the therapy session is going to be focused on mobilization of shoulder, passive movements into flexion and abduction of shoulder, soft tissue techniques of upper back and neck, and trigger point treatment of supraspinatus and infraspinatus.

Therapy execution:

1) Post isometric relaxation of trapezius muscle (23)

2) Triggerpoint therapy of infraspinatus

3) Triggerpoint therapy of supraspinatus

4) Soft tissue techniques of upper back and neck

5) Passive movements into flexion

6) Passive movements into abduction

7) Postisometric traction of shoulder (23)

8) Shoulder mobilization in ventral direction (23)

9) Shoulder mobilization in caudal direction (23)

10) Shoulder mobilization in dorsal direction (23)

Self therapy: Patient is instructed to lie in a prone position on the bed with shoulder outside of the edge, relax it and let it go from flexion to extension with the least possible muscle activation.

Conclusion of todays unit: Patient experienced a lot of physical discomfort during this therapy session. She showed, however, some increase of ROM of the shoulder joint. The patient handles pain well, but one should be careful in the future, not to exceed the pain limitation. Her limited ventilation capacity gave some problems in PIR exercises, so breathing exercises should be added to the therapy regime for the next session.

Day to day therapy

Date: 12.02.10 Time: 13.00

Status

Subjective: The patient feels much better today. She says her pain level is at 6 on the pain scale. She also states that ADL's are much easier to perform, although she still has to use her right, non-affected, limb when showering.

Objective:

Both hands over head: Much better than during initial examination. The patient manages to touch side of head with left hand without flexion and lateral flexion of head. She complains of less pain, but movement is still rigid

Hands to back from below: The patient is able to touch the middle of the lower back

Hands to back from above: The patient reaches level of acromion on opposite side when testing left arm

Hands over head: Patient manages to lift the shoulder slightly more than 80°, but this is really painful and she ends the movement shortly after.

Active flexion: 80°

Active abduction: 45°

Objective of today: The patient looks a lot better. She undresses with more ease than the first meeting. Active and passive movements are greater than on the initial examination.

Therapy proposal

Today's therapy unit should be focused on increasing joint play in the shoulder joint using manual methods. As the patient is able to reach starting position for PIR of internal and external rotators of the shoulder joint, this should be added together with STT to decrease hypertonus and triggerpoints of rotator cuff muscles. A further education and awareness of breathing patterns should also be done, so that the new breathing pattern, introduced on the previous therapy session, feels more natural.

Therapy execution:

1) Breathing therapy and education, abdominal breathing

2) Triggerpoint therapy of supraspinatus

3) Triggerpoint therapy of infraspinatus

4) Soft tissue techniques of upper back and neck

5) PIR for external rotators (23)

6) PIR for internal rotators (23)

7) Postisometric traction of shoulder joint (23)

8) Shoulder mobilization in ventral direction (23)

9) Shoulder mobilization in caudal direction (23)

10) Shoulder mobilization in dorsal direction (23)

11) Movements against scapula (23)

Conclusion: Today's therapy unit was important to check whether the therapy applied in the first therapy session was of any use. The tests performed showed that the ROM has increased and the pain level has decreased. I have also chosen to add some breathing therapy to the therapy regime to help to the PIR techniques. Patient is now also able to maintain the starting position of PIR of external and internal rotators of the shoulder joint, so this is also added to help decrease the hypertonus detected in the initial kinesiological examination. The PIR was performed with pain, but she felt a release of muscle tension after the technique was performed

Day to day therapy

Date: 15.2.10 Time: 13.00

Status

Subjective: Patient says less pain is present during movement of the shoulder joint. She states that her pain level is at 5 on a scale from 1-10.

Objective:

Both hands over head: Reaches the top of the head with both hands without flexion and lateral flexion of head.

Hands to back from below: Reaches middle lower back. Pain is bearable.

Hands to back from above: Reaches level just below acromion of opposite side

Hands over head: Reaches above shoulder level. No problems in dressing

Active flexion: 90°

Active abduction: 50°

Objective of today: Patient dresses and undresses with more ease than ever. She is also more positive than in previous sessions.

Therapy proposal:

Further work on manual methods to increase joint mobility is necessary in order to increase ROM in shoulder joint. Breathing therapy is indicated to relax patient and gain better results on therapy, and to educate patient in a better pattern of breathing. Triggerpoint and methods of decreasing hypertonus, such as PIR and STT is also indicated for muscles around the scapula and upper back and neck. As the patients state has improved, PNF techniques are introduced to facilitate and relax muscles included in the first diagonal.

Therapy execution:

1) Breathing exercises, localized breathing in abdominal area

2) Triggerpoint treatment of supraspinatus and infraspinatus

3) Soft tissue techniques of upper back and neck

4) PIR for external rotators (23)

5) PIR for internal rotators (23)

6) Postisometric traction of shoulder joint (23)

7) Shoulder mobilization in ventral direction (23)

8) Shoulder mobilization in caudal direction (23)

9) Shoulder mobilization in dorsal direction (23)

10) Movements against scapula (23)

11) PNF, 1. Diagonal flexion and extension patterns (24)

Conclusion: The tests show that the therapy is proceeding in the right direction. Patient expresses less pain than before and the ROM is significantly increased. The patient's ability to perform movements is also better, as she dresses and undresses with more ease than ever. For the first time the patient was introduced to PNF techniques. The first time it was only an introduction to the movements, and the patient had some difficulties in performing it in a correct manner, and she could not perform the diagonal to the full extent due to restricted ROM and pain. Patient however showed good muscle coordination and muscle strength.

Day to day therapy

Date: 17.02.10 Time: 13.30

Status

Subjective: Patient states that she has been in a lot of pain in the last 12 hours. Especially, the previous evening and the same morning. Pain was not present after the last therapy session. She states that her pain is at level 6 on a scale from 1-10. Patient suggests change in weather as a possible cause of joint pain, although she has not experienced that prior to the accident or after the accident had occurred.

Objective:

Both hands over head: Reaches the top of her head with both hands in a good manner without limiting pain.

Hands to back from below: Still some pain in this movement, but pain is bearable. Reaches Middle of lower back with affected upper extremity

Hands to back from above: Reaches level just below acromion on the opposite shoulder

Hands over head: Still painful when trying to cross 90° of shoulder flexion

Active flexion: 95°

Active abduction: 70°

Objective of today: Patient has been in a pain since the previous evening, in both resting state and when moving shoulder joint. Pain has been decreasing since the same morning. Patient has not taking any medication for the pain.

Therapy proposal:

As ROM is still decreased in the shoulder joint, manual methods are indicated to improve this. As good results have been achieved with earlier PIR exercises, these are continued, together with breathing therapy. Patient still complains of stiffness in upper back and neck, and palpation showed both hypertonus and triggerpoints in this area. STT and triggerpoint treatment is therefore indicated. PNF is continued. Patient was introduced to this in the last therapy session, and this should be continued to see results.

Therapy execution:

1) Breathing exercises, localized breathing in abdominal area

2) Triggerpoint treatment of supraspinatus and infraspinatus

3) Soft tissue techniques of upper back and neck

4) PIR for external rotators (23)

5) PIR for internal rotators (23)

6) Postisometric traction of shoulder joint (23)

7) Shoulder mobilization in ventral direction (23)

8) Shoulder mobilization in caudal direction (23)

9) Shoulder mobilization in dorsal direction (23)

10) Movements against scapula (23)

11) PNF, 1. Diagonal flexion and extension patterns (24)

Conclusion: Due to the patient's pain, the therapy was moderated according to her commands. A lot of breaks were used but due to a long therapy session we managed to get through all of the techniques. The patient's breathing is much better at the moment, and the triggerpoints around scapula and paravertebrals are significantly decreased. As patient was introduced to the PNF diagonals the previous therapy session, this session was dedicated to a more efficient therapy using the diagonals. However, a decision was made to just go through the 1st diagonal in both directions with no use of strengthening techniques, as the patient needs to go through the patterns more often, in order to perform them in a correct manner. This is to prepare the patient for further therapy using PNF techniques, when there is a greater indication for its use.

Day to day therapy

Date: 19.02.10 Time: 14.30

Status

Subjective: The patient expresses less pain than the previous therapy session. Easier to perform ADL's, but she is compensating a lot with her non-affected upper extremity. She states that the pain is at the level of 5 on a scale from 1-10.

Objective:

Both hands over head: Good manner of movement of the affected upper extremity. Almost no pain during the movement

Hands to back from below: Performed in a good manner and reach level of Th/L-crossing in the middle of low back

Hands to back from above: Reaches the level of superior border of scapula. No pain noted during performance of the movement.

Hands over head: Reaching a position of shoulder level with no problems. Painful when doing movements in this position.

Active flexion: 100°

Active abduction: 90 °

Objective of today: Since this session is also including the examination, the therapy part is a bit shortened, so as not to interfere too much with the test results. Breathing examination and PNF is excluded in this therapy session as it is time consuming and would cause lack of time for the final kinesiological examination.

Therapy proposal:

As usual, manual methods are indicated for the shoulder joint. Today, the amount of therapy should be limited, as pain should be avoided because of the following final examination. PIR techniques should be emphasized and patient should be educated in AGR methods for PIR of rotator muscles, as this is the last therapy session. Breathing therapy is indicated, as usual, to relax the patient and to improve results of the PIR therapy. PNF is don't indicated today, as it is the most time consuming technique and today's time span is limited

Therapy execution:

1) Triggerpoint treatment for infraspinatus and supraspinatus.

2) Soft tissue techniques for upper back and neck

3) PIR for external rotators (23)

4) PIR for internal rotators (23)

5) Postisometric traction of shoulder joint (23)

6) Shoulder mobilization in ventral direction (23)

7) Shoulder mobilization in caudal direction (23)

8) Shoulder mobilization in dorsal direction (23)

9) Movements against scapula (23)

Conclusion: The patient is now used to the therapy regime. Especially good results for PIR for external and internal rotators were observed today. Patient expressed pain during the triggerpoint treatment, and that therapy was aborted after a while to continue with the final examination. PNF was also excluded to make time for the final examination.

3.6 Final Kinesiological Examination:

Performed 19.02.10

Changes from the Initial Kinesiological Examination are marked with bold letters

Postural examination

Anterior:

- External rotation of feet
- Physiological arches of feet (both longitudinal and transversal)
- External rotation of knee, **not to the same extent**
- **Arms alongside body**
- Head rotated to the left side
- Right shoulder elevated, **slightly, not as marked, as on the initial examination**

Posterior:

- Brachioradial triangle bigger on right side**. Slightly, not as marked as on the initial examination**
- Sinister convex in lumbar spine, **small**
- Dexter convex in thoracic spine, **small**
- **Medial border parallel to the spine on left side**
- External rotation of lower angle of scapula right side**. small**
- **No scapula alata noted**
- Elevation of right shoulder**, small, not to the same extent as on the initial examination**

Lateral:

- **Straight elbows**
- Protracted shoulders
- Forward head position

Pelvis examination

Crista: **Level**

Spina iliaca anterior superior: **Level**

Spina iliaca posterior superior: **Level**

Balance and Proprioceptive tests

Vele: Negative

Romberg 1: Negative

Romberg 2: Negative

Romberg 3: Negative, but some instability at end of test period

Trendelenburg left leg: Positive.

Trendelenburg right leg: Positive

Functional movements:

Both hands over head: **Good manner of movement of the affected upper extremity. Almost no pain during the movement**

Hands to back from below: **Performed in a good manner and reach level of Th/L-crossing in the middle of low back**

Hands to back from above: **Reaches the level of superior border of scapula. No pain noted during performance of the movement.**

Hands over head: **Reaching a position of shoulder level with no problems. Painful when doing movements in this position.**

Sensation examination

Superficial skin sensation: Sensation tested on the whole upper extremity, neck and upper back. Patients feeling were normal over all.

Steroagnosia: Patient was tested inside palm with different digits. Patient had no problems differentiate.

Deep sensation, movement sense: Normal

Breathing, performed in lying position.

Type: **Abdominal breathing**

Frequency: **14 breaths per minute**

Notes: **Patient starts to breathe with an upper thoracic breathing type at first, but switches to abdominal breathing when she is relaxing. No use of accessory muscles are noted and patient breathes slowly and efficient.**

ROM (6)

	Left upper extremity		**Right upper extremity**	
Movement	**Active**	**Passive**	**Active**	**Passive**
Shoulder Flexion	**100°***	**110°***	130°	130°
Shoulder Extension	**30°**	**40°**	45°	45°
Shoulder ADD	0°	0°	0°	0°
Shoulder ABD	**85°***	**90°***	110°	120°
Shoulder ER	**40°***	**50°***	80°	85°
Shoulder IR	**20°***	**30°***	65°	70°
Elbow Flexion	130°	**155°**	150°	150°
Elbow Extension	0°	0°	-5°	-5°
Elbow Supination	90°	90°	90°	90°
Elbow Pronation	90°	90°	90°	90°
Wrist Dorsiflexion	**75°**	80°	70°	85°
Wrist Palmarflexion	80°	80°	80°	80°
Wrist Radial duction	30°	30°	30°	30°
Wrist Ulnar duction	25°	25°	25°	25°

Table 18

*= Movement accompanied with pain

Joint play (23)

Explanation to tables:

O= No blockage X= Blockage XX= Blockage with pain XXX= Impossible to perform due to pain

Interphalangeal joints (proximal and distal):

Interphalangeal joint, right upper extremity					
Digit	**1st**	**2nd**	**3rd**	**4th**	**5th**
Dorsopalmar	O	O	O	O	O
Laterolateral	O	O	O	O	O
Rotation	O	O	O	O	O
Lateral	O	O	O	O	O
Interphalangeal joint, left upper extremity					
Digit	**1st**	**2nd**	**3rd**	**4th**	**5th**
Dorsopalmar	O	O	O	O	O
Laterolateral	O	O	O	O	O
Rotation	O	O	O	O	O
Lateral	O	O	O	O	O

Table 19

Metacarpophalangeal joints 2-5th digit

Metocarpophalangeal joints 2-5th digit, right upper extremity				
Digits	**2nd**	**3rd**	**4th**	**5th**
Dorsopalmar	O	O	O	O
Laterolateral	O	O	O	O
Rotation	O	O	O	O
Metocarpophalangeal joints 2-5th digit, left upper extremity				
Digits	**2nd**	**3rd**	**4th**	**5th**
Dorsopalmar	O	O	O	O
Laterolateral	O	O	O	O
Rotation	O	O	O	O

Table 20

Metacarpophalangeal joint of the thumb

Metacarpophalangeal joint of the thumb		
	Right thumb	**Left thumb**
Dorsopalmar	O	O

Table 21

Intercarpal joints

Intercarpal joints		
	Right side	**Left side**
Palmar	O	O
Palmar, lateral segments	O	O
Pisiform	O	O
Schapoid	O	O
Capitate	O	O
One carpal to the other	O	O

Table 22

Radiocarpal joint

Radiocarpal joint		
	Right side	**Left side**
Dorsal direction	O	O
Dorsal direction, radial side	O	O
Dorsal direction, ulnar side	O	O
Proximal row, radial direction	O	O

Table 23

Distal radioulnar joint

Distal radioulnar joint		
	Right side	**Left side**
Shearing	O	O

Table 24

Elbow joint

Elbow joint		
	Right side	**Left side**
Radial	O	X
Ulnar	O	X
Head of radius, ventral	O	X

Table 25

Shoulder joint

Shoulder joint		
	Right side	**Left side**
Ventral	O	X
Dorsal	O	**X**
Caudal	O	**X**
Lateral	O	**XX**

Table 26

Scapular movements

Scapular movements		
	Right side	**Left side**
Movement of scapula against trunk	O	X
Abduction with elevation	O	X

Table 27

Sternoclavicular joint

Sternoclavicular joint		
	Right side	**Left side**
Springing distraction	O	O

Table 28

Muscle strength test (6)

	Right side	Left side
Biceps brachii	4+	**4**
Triceps brachii	4+	**4**
Brachioradialis	4	**4**
Supinator	4	4
Pronator teres/quadratus	4	**4**
Coracobrachialis	4	**4-**
Deltoid, whole muscle	4	**4**
Deltoid, anterior	4	**4**
Deltoid, posterior	4	**4-**

Table 29

(*)= with pain

Examination against isometric resistance of the rotator cuff muscles of the shoulder, (23)

	Right side	Left side
Against abduction	No pain	No pain
Against external rotation	No pain	Pain
Against internal rotation	No pain	Pain
Against raising of semi flexed arm	No pain	**Slight pain in left elbow**

Table 30

Palpation of muscles

	Right side			Left side		
	Tonus	**Pain**	**Trg. point**	**Tonus**	**Pain**	**Trg.point**
Biceps brachii	Hypo	No	No	**Normal**	No	No
Triceps brachii	Hypo	No	No	Hypo	No	No
Deltoid	Normal	No	No	**Normal**	Slight	No
Trapezius	Normal	No	No	Hyper	**No**	**No**
Supraspinatus	Normal	No	No	Hyper	Yes	**No**
Infraspinatus	Normal	No	No	Hyper	Yes	**No**
Subscapularis	Normal	No	No	Hyper	Yes	**No**
Paravertebral	Hyper	**Slight**	Yes	Hyper	Yes	Yes

Table 31

Scale test

Right side	**Left side**	
20 kg	23kg	
	Total	43 kg

Table 32

Anthropometry performed in lying position

	Right upper extremity	**Left upper extremity**
Upper arm circumference	19 cm	**20 cm**
Forearm circumference	20 cm	**19.5 cm**
Upper arm length	31 cm	30 cm
Forearm length	22 cm	23 cm
Whole arm length	70 cm	68 cm

Table 33

3.7 Evaluation of the Effects of Therapy

Tables of the changes during therapy.

Postural examination

	10.02.2010	19.02.2010
Anterior		
	External rotation of knee	**External rotation of knee, not to the same extent**
	Semiflexion and small internal rotation of left arm	**Arms alongside body with no rotation**
	Right shoulder elevated	**Right shoulder elevated, slightly, not as marked as on the initial examination**
Posterior		
	Brachioradial triangle bigger on right side	**Brachioradial triangle bigger on right side. Slightly, not as marked as on the initial examination**
	Sinister convex in lumbar spine	**Sinister convex in lumbar spine, small**
	Dexter convex in thoracic spine	**Dexter convex in thoracic spine, small**
	Internal rotation of lower angle of scapula, left side	**Medial border parallel to the spine on left side**
	External rotation of lower angle of scapula right side	**External rotation of lower angle of scapula right side. small**
	Scapula alata noted on right side, small	**No scapula alata noted**
	Elevation of right shoulder	**Elevation of right shoulder, small, not to the same extent as on the initial examination**
Lateral		
	Semiflexed elbow	**Straight elbows**

Table 34

Pelvis examination

	10.02.2010	**19.02.2010**
Crista	0.5 cm higher right side	**Level**
SIAS	0.5 cm higher right side	**Level**
SIPS	0.5 cm higher right side	**Level**

Table 35

ROM (6)

Left upper extremity

	10.02.2010		**19.02.2010**	
Movement	**Active**	**Passive**	**Active**	**Passive**
Shoulder Flexion	70°*	80°*	**100°***	**110°***
Shoulder Extension	20°	20°	**30°**	**40°**
Shoulder ADD	0°	0°	0°	0°
Shoulder ABD	40°*	50°*	**85°***	**90°***
Shoulder ER	30°X*	35°X*	**40°***	**50°***
Shoulder IR	15°X*	20°X*	**20°***	**30°***
Elbow Flexion	130°	150°	130°	**155°**
Elbow Extension	0°	0°	0°	0°
Elbow Supination	90°	90°	90°	90°
Elbow Pronation	90°	90°	90°	90°
Wrist Dorsiflexion	50°	80°	**75°**	80°
Wrist Palmarflexion	80°	80°	80°	80°
Wrist Radial duction	30°	30°	30°	30°
Wrist Ulnar duction	25°	25°	25°	25°

Table 36

X= Impossible to measure due to inability to reach starting position

*= Movement accompanied with pain

Joint play (23)

O= No blockage X= Blockage XX= Blockage with pain XXX= Impossible to perform due to pain

Shoulder joint, left		
	10.02.2010	**Left side**
Ventral	X	X
Dorsal	XX	**X**
Caudal	XX	**X**
Lateral	XXX	**XX**

Table 37

Muscle strength test (6)

	10.02.2010	**19.02.2010**
Biceps brachii	3+(*)	**4**
Triceps brachii	3+(*)	**4**
Brachioradialis	3+(*)	**4**
Supinator	4	4
Pronator teres/quadratus	3+	**4-**
Coracobrachialis	3+	**4**
Deltoid, whole muscle	3+(*)	**4**
Deltoid, anterior	3+(*)	**4**
Deltoid, posterior	3+(*)	**4-**

Table 38

Examination against isometric resistance of the rotator cuff muscles of the shoulder according to Cyriax, (23)

	10.02.2010	**19.02.2010**
Against abduction	No pain	No pain
Against external rotation	Pain	Pain,
Against internal rotation	Pain	Pain
Against raising of semi flexed arm	Pain	**Slight pain in left elbow**

Table 39

Palpation of muscles

	10.02.2010 Left side			19.02.2010 Left side		
Biceps brachii	**Tonus**	**Pain**	**Trg.point**	**Tonus**	**Pain**	**Trg.point**
Triceps brachii	Hypo	No	No	**Normal**	No	No
Deltoid	Hypo	No	No	Hypo	No	No
Trapezius	Hyper	Slight	No	**Normal**	Slight	No
Supraspinatus	Hyper	Yes	Yes	Hyper	**No**	**No**
Infraspinatus	Hyper	Yes	Yes	Hyper	Yes	**No**
Subscapularis	Hyper	Yes	Yes	Hyper	Yes	**No**
Paravertebral	Hyper	Yes	Yes	Hyper	Yes	**No**
	Hyper	Yes	Yes	Hyper	Yes	Yes

Table 40

Anthropometry

	10.02.2010	**10.02.2010**
Upper arm circumference	18 cm	**20 cm**
Forearm circumference	19 cm	**19.5 cm**
Upper arm length	30 cm	30 cm
Forearm length	23 cm	23 cm
Whole arm length	68 cm	68 cm

Table 41

4. Conclusion

I chose my patient because she was visiting the clinic for the first time during my practice, and that gave me a perfect opportunity to see the progress of the therapy from the beginning. When she arrived at the clinic for the first time she was in pretty bad shape, and she was complaining about a lot of pain in shoulder area. Her ROM was very restricted, especially into flexion and abduction. This was preventing her from doing her ADL's, and she expressed frustration because she was not as independent as she wanted to be. The therapy plan was therefore based on increasing ROM and reducing pain.

At CLPA, the clinic where I underwent my practice, it was normal to perform manual methods according to Lewit for this type of diagnosis. Together with her restricted joint play in the shoulder area, I chose to perform the same, because I thought that it would be in the patients interest for a faster rehabilitation, and because I did not want the patient to undergo a new therapy regime, when I was no longer at the clinic, especially as the patient was undergoing treatment for a longer period after my practice finished. Everything considered, I thought that this was the best option to proceed with for treatment.

I also added some muscle relaxation techniques, to release tension, hypertonus and triggerpoints in muscles detected on the initial examination, as I suspected that it could be the cause of patient's pain, as pain occurred especially during movement.

As the patient was diagnosed with asthma and she had a faulty breathing pattern detected by examination, I introduced some breathing techniques to fulfill my therapy. This was done, due to the fact she was overusing her accessory breathing muscles, and as PIR techniques which include breathing, were difficult to perform. Overuse of accessory muscles could in the long term lead to hypertonus and triggerpoints, and by removing the cause of this, PIR would be more successful. Patient also had troubles in breathing in an instructed manner during PIR, but with breathing therapy it improved.

PNF was also briefly introduced to the patient to facilitate muscles that have remained inactive and strengthen muscles. It was thought that therapy should be based on PNF techniques in a later stage of the therapy plan.

When comparing the initial and final examinations, a huge improvement in movement of the shoulder joint was found. Although the restricted joint play in shoulder did not

diminish, the degree of ROM and ability to perform the functional movements increased significantly. These should be considered as more important parameters in this patient, as the goal of therapy is to increase ROM and make the patient more independent. As the patient was just commencing her therapy when the initial examination was performed, a natural improvement was expected, but the extent to which she improved was maybe due to the fact that therapy sessions where relatively long, leading to high quality therapy. Breaks in therapy were allowed when the patient expressed pain. Other techniques that normally would not be done in this diagnosis were also done due to the same reason. This was mainly focused on STT and triggerpoint treatment, which was leading to the decrease of pain. In a broader view this could also be seen as an important factor in increasing movement of shoulder joint, as the patient expressed pain during active movements.

Greater strength in the affected extremity is desired, but the patient showed reduced strength also in the non-affected upper extremity, so strengthening techniques should be performed on both sides, and preferably with co-activation of both sides, to avoid development of muscle imbalance.

For future therapy, exercises focusing on increasing the deep stabilization system around the shoulder area are advised. This could be done on a posturomed or gymball. Exercises could also be done with propriomed or thera bands. It is, however, important to continue the already applied therapy for a while, so that the patient is able to maintain a correct starting position. The patient should be encouraged to do self therapy, and to keep active as much as possible. Exercises should be limited by pain. The patient should also continue practicing her new breathing pattern, and it is strongly advised for the patient to stop smoking, especially because of her asthma and faulty breathing pattern.

Considering the whole therapy, and the two weeks I was together with the patient, the therapy applied was a success. It is, however, important that rehabilitation is followed up and that the patient is doing some home exercises. The patient was positively receptive to new techniques, and understood instructions without noticeable difficulties, and was able to follow them. Taking the patient's age and status into consideration, a fully functional left upper extremity is highly unlikely to re-occur. However if one is able succeed in increasing the patient's independence and also decrease her pain level by therapeutic methods, her life quality would be comparable to the period before the

fracture occurred. The patient is right-handed, but a reasonable function of the left upper extremity is of course desired.

5. List of literature

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6. Supplement

6.1 List of tables

6.2 List of figures

Figure 1 & 2: **Faller A, Schanke M.** *The human body.* New York. Georg Thieme Verlag, 2004. 3-13-129271-7

Figure 3: **Wiss, Donald A.** *Fractures.* Philadelphia : Lippincott, Williams & Wilkins, 2006. 0-7817-5290-6.

6.3 List of Abbreviations

AC-joint- Acromioclavicular joint

ABD- Abduction

ADD- Adduction

ADL- Activities of daily living

AGR- Anti gravity

AM- Ante meridiem=before noon

BMI- Body mass index

CLPA- Centrum Léčby Pohybového Aparátu Vysočany (clinic)

Cm- Centimeter

E.g.- Exempli gratia=for the sake of example=for example

ER_ External rotation

FTVS- Fakulta Telesne Vychovy a Sportu

I.e.- Id est=which means

IR- Internal rotation

Kg- Kilogram

Min- Minutes

N/A- Not applicable/Not available

PIR- Post isometric relaxation

PNF- Post neuromuscular facilitation

ROM- Range of motion

SC-joint- Sternoclavicular joint

SST- Soft tissue techniques

Trg. Point- Triggerpoint