CHARLES UNIVERSITY

FACULTY OF PHYSICAL EDUCATION AND SPORTS
DEPARTMENT OF PHYSIOTHERAPY

Case Study of Physiotherapeutic Treatment of a Patient after the Surgical Intervention for Closed Proximal Humerus Fracture

Bachelor Thesis

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Prague, April 2024

Statement

I solely declare that this bachelor thesis was written by myself, using evidence based medicine from various research articles, books, journals and knowledge gained from lectures, seminars and practicals at FTVS UK.

I declare that the patient was fully informed about any examinations or therapeutic methods in advance and has given his written consent. There were no invasive methods used during treatment sessions.

Clinical practice and therapy sessions were always under full supervision and guidance of Bc. Tomáš Modlinger in Regional Kladno Hospital and approved and reviewed by Mgr. Michaela Stupková at department of Physiotherapy, FTVS UK.

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Kateryna Danylova

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Abstract in English

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Title: Case Study of Physiotherapeutic Treatment of a Patient after the Surgical Intervention for Closed Proximal Humerus Fracture

Objective: Physiotherapeutic approach for the patient after a traumatic proximal humerus fracture, followed by a surgical intervention (ORIF method). The practical aim of this thesis is to collect medical history and provide physical examination and treatment of patients after chronic proximal humerus fracture. The theoretical aim of this thesis is to investigate every aspect of proximal humeral fractures- their anatomy, kinesiology, incidence, clinical picture, and treatment options using evidence-based medical books, articles, and journals.

Methods: The unique physiotherapeutic approach used in this case study involved a comprehensive first session that included collecting anamnesis and gathering an initial kinesiologic examination of the patient. This was done using techniques of Czech and international doctors and physiotherapists, including specific examinations such as ROM examination acc. to the American Medical Association, muscle length test acc. to Janda and Kendall muscle strength test acc. to Kendall, basic movement pattern acc. to Janda, joint play and soft tissue acc. to Lewit, basic neurological examination acc. to Kolar and other nonspecific psychotherapeutic examinations. The total of eight therapeutic sessions, each lasting an hour long, included the methods and approaches of Czech and international doctors and physiotherapists. Following therapeutic methods included DNS acc. to Kolar , PNF acc. to Kabat, STT and PIR acc. to Lewit, PIR with stretching acc. to Janda and other nonspecific psychotherapeutic approaches. The last session included a complete kinesiologic examination for comparison.

Results: After eight sessions of hour-long physiotherapy in four weeks, there was no drastic improvement in the patient's condition compared to the initial examination. The effect of the therapy got rid of shortened and hypertonic muscles, joint blockages, and improved functional use of the left upper extremity in ADLs. The patient also became more confident whilst driving (turning the wheel). The main goal was to restore the maximum possible active range of motion and muscle strength. However, achieving this after eight sessions was impossible due to the chronicity of the fracture, pain, and structural changes of soft tissues (scar, in particular) and the bone.

Conclusion: Although the desired effect was not fully achieved, the patient is fully independent, with only minor difficulties present during his ADL, such as cooking. Since the non-dominant limb was affected and the fracture was chronic (almost two years had gone at that moment), it was hard to achieve the main aim of the therapy, which is maximal active ROM and muscle strength test. However, improvements were still observed in terms of soft tissue and joint play. After our sessions, the patient is referred to an intensive month-long rehabilitation in the spa centre, where he will continue to work for his primary goal.
Keywords: Traumatology, fractures, proximal humerus fracture, shoulder girdle, surgical intervention, rehabilitation, physiotherapy, physical therapy.

Anotace v Češtině

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Instituce: Fakulta tělesné výchovy a sportu, UK

Název práce: Kazuistika Fyzioterapeutické Péče o Pacienta po Chirurgickém Zákroku pro Proximální Zlomeninu Humeru

Cíl: Fyzioterapeutický přístup u pacienta po traumatické zlomenině proximálního humeru s následným chirurgickým zákrokem (metoda ORIF). Praktickým cílem této práce je získat anamnézu, zajistit kineziologické vyšetření a léčbu pacienta po chronické zlomenině proximálního humeru. Teoretickým cílem této práce je prozkoumat každý aspekt diagnózy mého pacienta – anatomii, kineziologii, výskyt, klinický obraz, možnosti léčby dle lékařských knih, článků a vědeckých časopisů založených na důkazech.

Metody: První sezení zahrnovalo získání anamnézy a vstupní kineziologické vyšetření pacienta pomocí technik českých i zahraničních lékařů a fyzioterapeutů. Specifická vyšetření zahrnovala vyšetření rozsahu pohybu dle Americké lékařské asociace, test délky svalů podle Jandy a test svalové síly podle Kendall, základní pohybový vzorec dle Jandy, vyšetření kloubní vůle a měkkých tkání dle Lewita, základní neurologické vyšetření dle Koláře a další nespecifická psychoterapeutická vyšetření. Proběhlo celkem osm terapeutických sezení, každé v délce jedné hodiny, používající metody a přístupy českých i zahraničních lékařů a fyzioterapeutů. Terapie zahrnovaly metody DNS podle Koláře, PNF dle Kabáta, STT a PIR dle Lewita, PIR s protažením dle Jandy a dalšími nespecifickými psychoterapeutickými postupy. Poslední sezení zahrnovalo kompletní kineziologické vyšetření pro srovnání.

Výsledky: Po osmi sezeních trvajících hodinu v rozsahu čtyř týdnů nedošlo oproti vstupnímu vyšetření k žádnému radikálnímu zlepšení stavu pacienta. Efektem terapie se zbavili zkrácených a hypertonických svalů, kloubních blokád a zlepšilo se funkční využití levé horní končetiny u ADL. Navíc, se pacient stál jistější v řízení (točení volantem). Hlavním cílem bylo obnovit maximální možný aktivní rozsah pohybu a svalovou sílu, nicméně po osmi sezeních tohoto cíle nebylo možné dosáhnout kvůli chronické zlomenině, bolesti a strukturálních změn měkkých tkání (zejména jizvy) a kosti.

Závěr: Přestože požadovaného efektu nebylo plně dosaženo, pacient je plně samostatný, pouze má menší obtíže při jeho ADL, jako je vaření. Vzhledem k tomu, že byla postižena nedominantní končetina a zlomenina je chronická (v tu chvíli uběhly téměř dva roky), bylo těžké dosáhnout hlavního cíle terapie, kterým je maximální aktivní ROM a test svalové síly,

přesto došlo ke zlepšení pozorováno z hlediska funkčnosti měkkých tkání a kloubů. Po našich sezeních je pacient odeslán na intenzivní měsíční rehabilitaci v lázeňském centru, kde bude pokračovat v rehabilitaci k dosažení plné funkce a síly končetiny.
Klíčová slova: Traumatologie, zlomeniny, zlomenina proximálního humeru, ramenní pletenec, chirurgická intervence, rehabilitace, fyzioterapie, fyzikální terapie.

Abbreviations

ABD - Abduction
AC - Acromioclavicular
Acc. - According to
ADD - Adduction
ADL - Activity of Daily Living
AROM - Active Range of Motion
BMI - Body Mass Index
CKC - Closed Kinematic Chain
CWP - Clinical Work Placement
DTR- Deep Tendon Reflexes
EMG - Electromyography
EXT - Extension
FLX - Flexion
GH - Glenohumeral
HAZ- Hyperalgesic Zones
MRI - Magnetic Resonance Imaging
OKC - Open Kinematic Chain
ORIF - Open reduction internal fixation
OT- Occupational therapy
OTA - Orthopaedic Trauma Association
PHF - Proximal humerus fracture
PIR - Post Isometric Relaxation
PNF - Proprioceptive Neuromuscular Facilitation
PROM - Passive Range of Motion
RSA - Reverse shoulder arthroplasty
SIAS- Spina iliaca anterior superior
SCM - Sternocleidomastoid
SIPS - Spina iliaca posterior superior
STT - Soft Tissue Technique
ST - Scapulothoracic
TBI - Traumatic Brain Injury
TH/L - Thoracic/ Lumbar
UE - Upper Extremity

Table of Content

INTRODUCTION

This bachelor thesis explores the conservative treatment of the patient after a traumatic fracture of the proximal humerus, followed by surgical intervention using the ORIF method. The bachelor thesis is composed of two parts. The first part discusses the theoretical background of the diagnosis- anatomy of the shoulder girdle, kinesiology, description of the diagnosis, incidence, clinical picture, etiopathogenesis, classification of the fracture, clinical examination, and rehabilitation, including physical therapy modalities and occupational therapy.

The second part comprises practical examinations and therapeutic methods for proximal humerus fracture. Eight therapeutic sessions, each lasting one hour, are held over four consecutive weeks. Each session starts and finishes with a brief kinesiology examination to compare the results from the previous session. Methods using neurophysiology principles such as PNF or DNS and other physiotherapeutic approaches are also included.

The 55-year-old patient came for a recurrent physiotherapy session 1.5 years after the proximal humerus fracture, followed by ORIF intervention. The patient had had previous physiotherapy sessions, during which significant improvement was observed. The main goal of the therapeutic block was to maximise muscle strength and maximally increase active ROM to the patient's ability.

This thesis aims to provide appropriate kinesiology examinations, prescribe and apply necessary therapy based on the initial examination, and compare the effects of the therapies based on initial and final examinations.

1 THEORETICAL PART

1.1 Anatomy of shoulder girdle

The shoulder is structurally and functionally complex. It is one of the most mobile parts of the human body due to its articulation at the glenohumeral joint. The shoulder girdle connects the upper limb to the axial skeleton via the sternoclavicular joint. The wide range of motion of the shoulder comes at the cost of reduced joint stability and the risk of dislocating or injuring the shoulder. The plexus of the upper limb is connected to the axial skeleton by two fitting joints - sternoclavicular joint and acromioclavicular joint, and two false joints (so-called functional joints) - thoracoscapular and subacromial joints. Girdle bones are the scapula and clavicle. The girdle of the upper limb is attached to the chest in such a way that it forms a three-sided space called the axillary fossa (fossa axillaris). Its peak is the shoulder joint, the front side is formed by the clavicle and the back side by the scapula together with the muscles that clamp them, and the medial side is formed by the side wall of the chest Shoulder girdle is made up of three main bones: clavicle, scapula and humerus (41). Muscles of the shoulder girdle are big in number and can be grouped into three categories:

1. Scapular stabilisers of the joint, which include serratus anterior, trapezius, pectoralis minor, rhomboids major et minor and levator scapulae
2. Glenohumeral stabiliser muscles and rotator cuff muscles including teres major et minor, supraspinatus, infraspinatus, subscapularis, coracobrachialis, biceps et triceps brachii
3. Large muscle group- shoulder movers, which include deltoid, latissimus dorsi and pectoralis major (42).

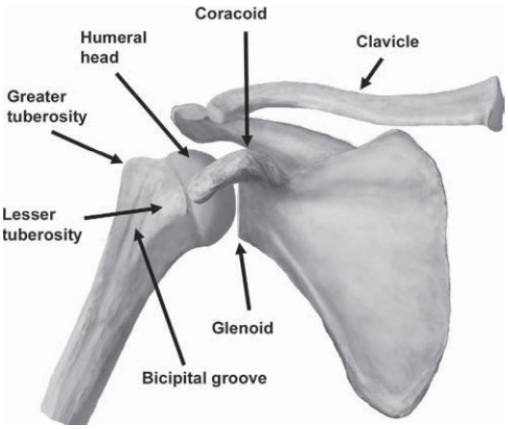

Figure no 1: The bony anatomy of the proximal humerus anterior view (13)

Shoulder girdle joint and whole upper and lower arm is supplied by brachial plexus, which is a complex network of nerves originating from the lower cervical and upper thoracic spinal nerves (C5-Th1). It supplies motor and sensory innervation to the upper limb and specific shoulder and neck muscles. The plexus is divided into roots, trunks, divisions, cords, and branches, each contributing to specific nerve distributions in the upper limb. The lateral, medial, and posterior cords give rise to terminal branches, which ultimately innervate specific muscles and regions of the upper limb. These branches include the musculocutaneous, axillary, radial, median, and ulnar nerves (50). Neurological injury of any peripheral nerve can lead to pain in the innervating area, loss of movement and/or sensation, loss or diminishing of deep tendon reflexes, weakness of the extremity, numbness, tingling, or burning sensation (1) (19). Regarding the circulatory system, the anterior humeral circumflex artery supplies the proximal humerus, the major arterial contributor to the humeral head. It is essential to be careful when dissecting the proximal humerus to avoid damaging the anterior ascending branch, which supplies blood to the humeral head. Disruption of this artery can lead to avascular necrosis. The posterior humeral circumflex artery also supplies blood to a small part of the articular surface. The humeral head is primarily supplied by vessels that enter through the rotator cuff insertions. Vascular injuries in this area are rare, occurring in only 5-6% of cases. The axillary artery is called the "tethered trifurcation" at the surgical neck level, and most vascular injuries occur just above the anterior circumflex humeral artery (3).

1.2 Kinesiology

The upper limbs serve humans and primates primarily as a manipulation and grasping organ. It is a system of interconnected, variously movable links that can be “telescopically” lengthened or shortened as needed. The root joint of this system is the shoulder joint, the most mobile joint in the body. The upper limb can be changed in length using the elbow joint. These two joints ensure the gross motor skills of the upper limb. Grasping ability and fine motor skills are primarily ensured by the hand, which has excellent mobility and dexterity. Both upper limbs form a paired grasping system and form a closed functional chain together. During manipulation, both usually work simultaneously, with the leading role of the dominant limb, and are supported by the non-dominant limb.

From a kinesiological point of view, we divide the upper limb into three segments:

1. proximal area of the upper limb - girdle of the upper limb, and shoulder joint
2. middle area of the upper limb - area of the elbow joint
3. distal region of the upper limb - wrist and hand

The upper limbs, while less tightly bound to the axial segment of the body compared to the lower limbs, still require basic postural stability for targeted manipulation. This unique anatomical characteristic of the upper limbs underscores their role as a versatile and adaptable tool for human interaction with the environment (57).

1.2.1 Kinesiology of shoulder girdle

The shoulder girdle is the bony framework that supports and connects the upper limb to the axial skeleton.

It consists of two prominent bones: the scapula, the clavicle, and their joints - sternoclavicular and acromioclavicular joints and two functional joints - thoracoscapular and subacromial. The active component of the girdle is the muscles. The entire girdle system (muscles, bones, joints) must withstand considerable pressure and weight load. This load is transferred through the clavicle to the sternoclavicular joint, the fossa glenoidalis, the scapula, and the first ribs. To prevent injury of this system, the correct activity and interplay of the individual are essential components of the segment. There is a constant compromise between the requirement to ensure excellent mobility and, at the same time, maintain maximum stability of the limb. The stabilising function of the girdle is ensured on the one hand by the sternoclavicular joint and on the other hand by a specific type of movement of the scapula, which causes a change in the position of the joint socket. Movement of the scapula is not possible on its own; the clavicle always moves simultaneously, and vice versa; it moves through the acromioclavicular joint. At the same time, the clavicle acts as a strut in order to resist longitudinal compression (16).

1.2.2 Scapula kinematics

1. Elevation is 40 degrees, and depression is 10 degrees.
2. Abduction and adduction with active protraction is 30 degrees, and retraction is 25 degrees of the shoulder girdle. It is a horizontal translation of the scapula from a posteromedial to an anteromedial position.
3. Lateral rotation of the inferior angle with active arm abduction or elevation and with 60 degrees of scapular rotation, the inferior angle moves approximately 10 cm laterally. In contrast, the superior angle is 2-3 cm inferior medial.
4. Rotation around a transverse axis during abduction, the superior scapular border tilts dorsally up to 23 degrees with 145 degrees of abduction (29).

Muscle groups surrounding the scapula form a partner pair with different activations, thanks to which the movement of the scapula is enabled, as well as its fixation in any position:

1. mm. rhomboidei x m. serratus anterior (scapula rotation)
2. m. levator scapulae x m. trapezius – lower part (elevation and depression of the scapula)
3. m. pectoralis minor x m. trapezius – upper part (forward bend, tilt of the scapula)
4. m. serratus anterior - upper and middle part x m. trapezius - middle part (abduction, adduction of the scapula)

These pairs of muscles, together with other girdle muscles, are involved in fixing the scapula and thereby setting the position of the socket of the shoulder joint, which is the support base for the head of the humerus during arm movements. The movements of the scapula further expand the arm's range of motion. (29)

1.2.3 Kinesiology of shoulder joint

The shoulder joint represents the free upper limb's connection with the upper limb's girdle or the humerus with the scapula - the glenohumeral joint. It is the most mobile joint in the body. From a functional point of view, however, a pair of joints – namely, the shoulder joint and the acromioclavicular joint- always work together comprehensively as a functional unit. Therefore, in some literature, the kinesiology of the upper limb girdle and the shoulder joint are not separated and are described together as the kinesiology of the shoulder girdle. The two segments are functionally closely linked together. Any change in the position of the glenohumeral joint causes a response in the acromioclavicular joint, and through the clavicle and scapula, movement also occurs in the sternoclavicular and scapulothoracic joints. Movements of the shoulder joint in the horizontal plane and above the horizontal could not be done without its simultaneous rotational movement of the scapula and clavicle. From a kinesiological point of view, we can observe a multi-articular complex of the shoulder girdle, which, in addition to the glenohumeral and acromioclavicular joints, also includes other joints that cannot be functionally separated from each other, mainly the sternoclavicular joint, scapulothoracic and subdeltoid joints. During movements, cooperation of all components of this complex is necessary (25)(57).

Passive components of the shoulder joint include the humerus, scapula, clavicle, sternum, and functionally 1-3 ribs, C spine, and Th spine. Active components include muscles: pectoralis major, latissimus dorsi, deltoideus, teres major, teres minor, supraspinatus, infraspinatus, subscapularis, coracobrachialis, biceps brachii and triceps brachii. Attached are parts of the

supraspinatus, infraspinatus, teres minor, and subscapularis, which attach to the tuberculum majus et minus humeri, together form the rotator cuff. Together with the ligaments and caput longum tendon, it provides the stability of the shoulder joint against subluxation, and it also affects the optimal setting of the humeral head in the glenoid fossa (16).

1.2.3.1 Humerus

The humerus, the long bone of the upper arm, is pivotal in upper limb function, extending from the shoulder joint to the elbow. This anatomical structure consists of a proximal end articulating with the scapula to form the shoulder joint and a distal end joining the radius and ulna at the elbow joint. Key features include its attachment sites for muscles critical in shoulder and arm movement. Additionally, the humerus harbours channels and foramina for the passage of nerves and blood vessels essential for arm sensation and vascular supply (54). It presents with a certain degree of torsion in which the distal end is in external rotation compared to the proximal one. Newborn's humerus has a torsion angle of 60 degrees, and with development and growth, the angle decreases to 16 percent in adulthood. The decrease of angle torsion happens due to the change in scapula position when developing. The joint socket, directed anteriorly in a newborn, is later oriented more laterally in adulthood. Caput humeri corresponds to 1/3rd of the ball with a 3 cm radius. The axis of the humeral head is pointed cranially, medially, and dorsally. The head of the humerus and the diaphysis form a 130-degree angle (29).

1.2.4 Shoulder joint kinematics

Movements in this joint happen along three axes: vertical, horizontal, and transverse. Simultaneous movement in all of the shoulder girdle joints allows for maximum ROM. Flexion 150-170 degrees and extension 40 degrees around the horizontal axis. Flexion can be further split into 3 phases:

1. 1st phase (0° - 60°) – in the glenohumeral joint
2. In the second phase (60° —120°), the scapula rotates by 60°, and then the axial rotation of the acromioclavicular and sternoclavicular joints occurs.
3. 3rd phase - (120° - 180°) - is very similar to the second phase; there will be a slight bending of the spine, and if both limbs are flexed at the same time, an increase in lumbar lordosis

During flexion, the main muscles that perform the movement are the deltoid, coracobrachialis, and biceps brachii muscles (caput breve). The auxiliary muscle is the pectoralis major, the

deltoideus muscle. The trapezius and subclavius muscles stabilise the movement. The infraspinatus and teres minor muscles have a neutralising function.

During extension, the main muscles are the latissimus dorsi, teres major, and deltoideus. The triceps brachii (caput longum), teres minor, subscapularis, pectoralis major m. The stabilising function has triceps brachii, coracobrachialis, rhomboid major and minor muscles, mm—intercostals, and mm. abdominis. The neutralising muscles are the deltoideus, the infraspinatus, and the teres minor.

Abduction is 180 degrees, and 20-40 degrees adduction in the sagittal axis. If abduction is above 90 degrees, it is automatically linked to the external rotation of the arm so that tuberculum majus does not compress coracoacromial space. The abduction range assisted by internal rotation decreases to 160 degrees. As flexion, abduction can be divided into three phases:

1. 1st phase (0° - 30°) – takes place only in the glenohumeral joint
2. 2nd phase (30° - 180°) – here, the elevation takes place in such a way that for every 15° of movement, 10° takes place in the glenohumeral joint and 5° in the thoracoscapular joint. During abduction of the arm, the rotational movement of the scapula is simultaneously associated with movement in the acromioclavicular and sternoclavicular joints, where in abduction up to 90°, every 10° of movement into abduction is associated with 4° of elevation of the lateral part of the clavicle. Above 90° of abduction, the total elevation of the limb also requires rotation of the clavicle around its longitudinal axis in the range of about 45° - 55°.
3. 3rd phase (150-180): Abduction of the shoulder joint is still connected with contralateral lateral flexion of the trunk. If both upper limbs are raised simultaneously, lumbar spine lordosis occurs.

During abduction, the main muscles in this movement are the deltoideus, the supraspinatus, and the serratus anterior. The deltoid, the infraspinatus, the pectoralis major, and the biceps brachii (caput longum) provide an auxiliary function. The trapezius muscle has a stabilising function. Neutralising functions have infraspinatus and teres minor muscles.

Adduction is ensured by the pectoralis major, latissimus dorsi, and teres major muscles. The teres minor, subscapularis, and triceps brachii muscles (caput longum) have an auxiliary function. The stabilising muscles are the serratus anterior and trapezius muscles. The muscles that perform internal and external rotation of the shoulder joint provide the neutralising function.

The arm moves in 90 degrees of abduction through horizontal adduction (130-160 degrees) and horizontal abduction (40-50 degrees).
External and internal rotations in the longitudinal axis depend on the degree of abduction of the shoulder joint. In zero position (arm along the body, elbow flexed), the range of rotation is 60 degrees. At 90 degrees of abduction, the external rotation is more significant (90 degrees) than the internal (70 degrees).
The main muscles of external rotation are the infraspinatus and the teres minor. The auxiliary muscle is the deltoid. The trapezius and rhomboids provide stabilisation.
The main internal rotation muscles are the subscapularis, the latissimus dorsi, and the teres major. The pectoralis major, deltoideus, biceps brachii, and coracobrachialis muscles have an auxiliary function. The pectoralis major and serratus superior ensure stability during movement. The deltoid, the coracobrachialis, the pectoralis major, the latissimus dorsi, and the teres major neutralise movement (16)(24)(25)(29).

1.2.5 Scapulohumeral rhythm

The humerus and the scapula move in a 2:1 ratio during abduction. That means 90 degrees of abduction, 60 degrees attributed to the glenohumeral joint and 30 degrees to scapular rotation. A change in scapulohumeral rhythm happens when there are deficits in shoulder girdle function. Usually, quicker scapular rotation occurs relative to the extent of humeral movement (29).

1.2.6 ADL movements

1. Bringing both hands behind the back- abduction is at 120° and external rotation at approximately 90° (e.g., bra fastening)
2. When putting the hand into the sleeve from the front, the movement consists of flexion and abduction. If the upper limb is being dressed from behind, an extension of approximately 15° and internal rotation from 100° to 110° is necessary (same for fastening the bra).

The articulation formula for intra-articular lesions according to Cyriax: The limitations are ER, ABD, and IR. The examination, according to Cyriax, also includes the movements of the scapula. According to Sachse, the examination is more accurate when the joint pattern is ABD, ER, and IR with a fixed scapula.
Cyriax's painful arc is used to diagnose pathologies in the shoulder joint. The principle is movement in the shoulder joint to maximum abduction:

1. With pain up to 30°, it is a supraspinatus disorder
2. Pain in the range from 30° to 60° indicates pathology of the subacromial bursa
3. Pain occurring in 60 to 120° of abduction indicates damage to the rotator cuff
4. Painful condition at 180°, when the lateral part of the clavicle is maximally rotated, indicates a disorder of the acromioclavicular joint (15).

1.3 Proximal humerus fractures

A proximal humerus fracture refers to a disruption in the continuity of the upper portion of the humerus bone, typically occurring near the shoulder joint. This type of fracture encompasses various patterns, including anatomical neck, surgical neck, and fractures involving more significant or lesser tuberosities. Proximal humerus fractures are a common orthopaedic injury, often encountered in individuals of advanced age due to osteoporosis or in younger individuals following trauma (44).

1.3.1 Characteristics of injury

1.3.1.1 Signs and symptoms

Alert patients with closed humeral fractures complain of localised shoulder pain and limitation of movement, particularly in abduction, flexion, and external rotation. The fracture, in most cases, is the result of a traumatic injury such as a fall, followed by the formation of bruises and swelling around the injured area. Numbness over the outside part of the upper arm and deltoid muscle weakness may indicate axillary nerve injury (13). Symptoms from poor blood circulation in the arm are uncommon due to collateral circulation. In polytraumatized or unconscious patients, proximal humeral fractures may go unnoticed clinically as attention is directed toward more life-threatening injuries. Furthermore, due to the bulk of the deltoid muscle, fracture deformity is not readily identifiable as in other anatomic locations (3).

1.3.2 Epidemiology and incidence

Fractures of the proximal humerus occur in all age groups and have peak bimodal distribution in the elderly due to osteoporosis and young people who have road traffic accidents. At less than approximately 50 years of age, high-energy trauma is the most common cause, and it occurs as a part of polytrauma. Proximal humerus fractures account for approximately 4-7% of adult fractures. It is the most common fracture of the humerus and the most common fracture at the shoulder girdle (13). Approximately 85% of the PHF are undisplaced or minimally displaced. The remaining 15% of fractures are displaced, resulting in orthopaedic

surgery (3). In the elderly, women have a much higher incidence than men because of osteoporosis (three times as many in women as in men). The incidence has increased exponentially to over 40% every five years at age 40 in females and 60 in males. In 2002, the average age of patients with proximal humerus fracture was 63 years (32). White females have the highest risk of suffering proximal humerus fractures (17). As with other osteoporosis-related fractures, additional risk factors for proximal humeral fractures include low bone mass and an increased risk of falls (4). In addition to this, patients with visual impairments, use of hearing aids, diabetes mellitus, depression, alcohol consumption, and use of anticonvulsant medicine have a higher risk of sustaining a proximal humeral fracture (17). Other fractures, for example, in the spine or other upper or lower extremities, have shown an increased risk of getting PHF. Fractures are more frequent during winter due to the increased risk of outside falls. Overall, patients with PHF are more fit than patients suffering proximal femur fractures but less than those with distal radius fractures. PHF has an increased risk for subsequent distal radius and proximal femur fractures (3). Patients with PHF have a greater than five times risk of suffering a hip fracture after a proximal humeral fracture (11).

1.3.3 Etiopathogenesis

Approximately half of all proximal humeral fractures occur at home, primarily due to falls on level ground. In individuals 60 years or older, over 90% of PHF results from a fall from a standard height. On the contrary, in younger individuals, there is a higher incidence of PHF occurring outside of the home as a consequence of high-energy trauma, such as motor vehicle accidents, sports, or assault (13). The PHF results from three different loading modalities: compressive loading of the glenoid on the caput humeri, bending forces at the collum chirurgicum, and tension forces of the rotator cuff at the tuberculum majus et minus. When the glenoid impacts caput humeri during the fall in healthy individuals, the proximal humeral epiphysis tends to resist compressive loads. The energy is then transferred distally to the vulnerable spot of collum chirurgicum, where the common fracture can occur. In the case of osteoporosis, weaker epiphyseal bone may yield simultaneously with the surgical neck, which can lead to more complex trauma of the humerus. The dislocation of the glenohumeral joint may cause isolated tuberculum majus fracture and even less common tuberculum minus fracture (30). Tension forces during the trauma can further displace structures because of the unstopped pull of the rotator cuff muscles (supraspinatus, infraspinatus, teres major et minor, subscapularis).

Apart from the bone density and quality, the injury is influenced by the kinetic energy passed along to the shoulder joint and the position of the upper extremity during the injury. In the case of high-energy fracture in the extension position, surgical neck structure has an influence, with humeral epiphysis being preserved. When falling onto the outstretched hand with the shoulder in flexion, abduction, and internal rotation, the glenoid forces the humeral head into the valgus, hinging around the anteromedial aspect of the stronger calcar bone. In case of a direct fall on the shoulder, there will be a varus deformity, which will most likely cause a posterior rotational deformity of the head (13).

1.3.4 Clinical picture

Clinical examinations usually show soft tissue swelling and, in many cases, a big ecchymosis, especially in elderly patients. There is also a loss of the regular convex contour of the shoulder, mostly in severe fractures, which include dislocation. However, local soft tissue signs might be absent in the acute stage, especially in overweight individuals. Open fractures are rare, but they should be ruled out by confirming skin integrity.

Individuals showing signs of numbness, tingling, burning sensation, or loss of sensation are suspicious of neurological damage to one of the peripheral nerves running along the surgical neck or anywhere alongside the humerus bone. In the case of a surgical neck fracture, axillary nerve sensation should be examined. Hypoesthesia over the lateral side of the proximal arm can signify axillary nerve damage. Vascular damage is present by weak or asymmetric pulse and should be examined. Furthermore, we should also examine radial pulse and capillary refill and compare it to the other side (3).

1.3.5 Pathokinesiological consequences for the musculoskeletal system

When we talk about pathokinesiological consequences, we are usually referring to the outcomes of long-term immobilisation of an extremity rather than the consequence of the fracture itself.

An example of this would be the loss of physiological movement patterns in the shoulder joint. In the case of UE fixation, a patient wears a Gilchrist or Velpeau-type shoulder immobiliser after both surgical and non-surgical management options. In both cases, the arm is positioned into elbow 90-degree flexion, shoulder adduction, and internal rotation. When fixed for a time required for bones and soft tissues to heal, which is approximately 6-8 weeks, the patient experiences difficulty moving with his arm, especially into external rotation, abduction, and flexion. Long-term immobilisation can lead to muscle weakness in the

shoulder and upper arm. Weakness may occur in the deltoid, rotator cuff muscles, and other muscles surrounding the shoulder joint. This weakness can contribute to further limitations in shoulder function.

Depending on the severity and displacement of the fracture, the shoulder joint may become unstable. Instability can result from ligamentous or capsular injury associated with the fracture or inadequate healing of the fracture fragments. Shoulder instability can lead to feelings of looseness.

Also, a PHF can disrupt the normal biomechanics of the shoulder joint, leading to altered movement patterns. Compensation mechanisms may develop to accommodate for pain, weakness, or instability, which can contribute to abnormal shoulder mechanics and potentially lead to overuse injuries or secondary musculoskeletal issues. Movement pattern can be checked by simple shoulder abduction movement, where an over-compensatory mechanism of trunk lateral flexion or overactivation of trapezius muscle might be seen. Even shoulder girdle elevation might start earlier or may even initiate the movement. We can also ask the patient to perform a modified push up against the wall to check for optimal scapular alignment and m—m-serratus anterior function. We also check for the smoothness of the movement returning from a pushup position. We are looking for physiological muscle synkinesis and optional scapular elevation and rotation (48).

Long-term immobilisation presents challenges of increased muscle tone of those muscles that were constantly activated in such a position. For example, due to UE being placed in IR, subscapularis, pectoralis, teres major, latissimus dorsi, and anterior aspect of deltoid hypertonicity. Or hypertonicity in biceps brachii, brachioradialis, and brachialis due to constant elbow flexion. Long-term changes in muscle tonicity can lead to the appearance of trigger points in muscle or muscle shortening.

1.3.5.1 Dyssynergia of muscle chains

Muscle chains are interconnected networks of muscles that work together to produce movement and maintain postural stability. These chains are organised in functional units rather than isolated muscles and are crucial in coordinating movement patterns and distributing forces efficiently across the body. One of the central concepts in Vele's approach is the idea of "tensegrity," which refers to the balance between tension and compression within the musculoskeletal system. According to Vele, muscles, fascia, and other soft tissues work together to create a dynamic network of tension and compression that supports posture, movement, and overall function. Fractures, followed by surgery or/long-term immobilisation,

can disturb those muscle chains. For example, we can take a crossed long torso chain (back side) that spasms from the humerus of one side - m. latissimus dorsi - fascia thoracolumbalis - spine - crista iliaca (of the other side) - fascia glutea - m. gluteus maximus - fascia lata - m. tensor fasciae latae - to the knee of the other side. In the case of the already mentioned hypertonic m. latissimus dorsi, due to position in IR, the changes in the tonicity of one muscle can affect the whole muscle chain, leading to further muscular disbalances down the ladder. Since there are spiral and vertical and spawn from the upper part of the body to the lower extremities, the pathological finding in one part immediately leads to changes in the other. Moreover, the movement will become stereotyped if those changes are unsolved in the long term. This means the brain will learn it as an optimal pattern and incorporate it into the subcortical level, which will be extremely difficult to fix (53)(57).

1.3.6 Classification of fractures

Fracture classification is primarily used to separate these fractures into treatment groups. It all started back in 1896 when Kocher classified these fractures based on the anatomical level of the fracture at the anatomical neck, metaphyseal region, and surgical neck at supra tubercular, per-tubercular, intratubular, and suborbicular. Because of its simplicity, fracture classification does not apply to many complex fracture patterns commonly encountered (3).

In 1934, Codman stated that the fracture lines of the proximal humerus reproducibly occurred between four major fragments, these being the caput humeri, tuberculum majus et minus, and corpus humeri proximal to the insertion of the pectoralis central tendon.

Codman evaluated 16 different fracture combinations, hence setting the foundation for PHF (13).

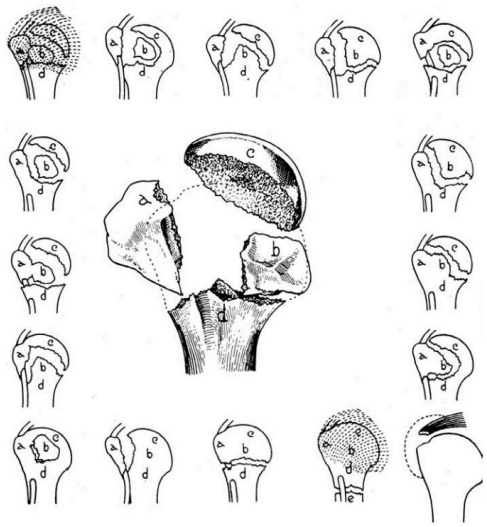

Figure no 2: Codman's original depiction of proximal humerus fractures. Fractures were described as occurring between the greater tuberosity (a), humeral head (c), lesser tuberosity (b) or shaft (d) (13).

1.3.6.1 Neer classification

The four-part classification reported by Neer in 1970 represents a refinement of Codman's four-segment classification that incorporates the concepts of displacement and vascular isolation of particular segments. Three of these segments correspond to the ossification centres, giving rise to the proximal humerus. This classification was the first comprehensive system that related the anatomy and biomechanical forces resulting in the displacement of fracture fragments to diagnosis and treatment. This is by far the most widely used and forms the language of communication. Even though this classification has a low amount of agreement between physicians using the classification system, formal training sessions may improve agreement (6).

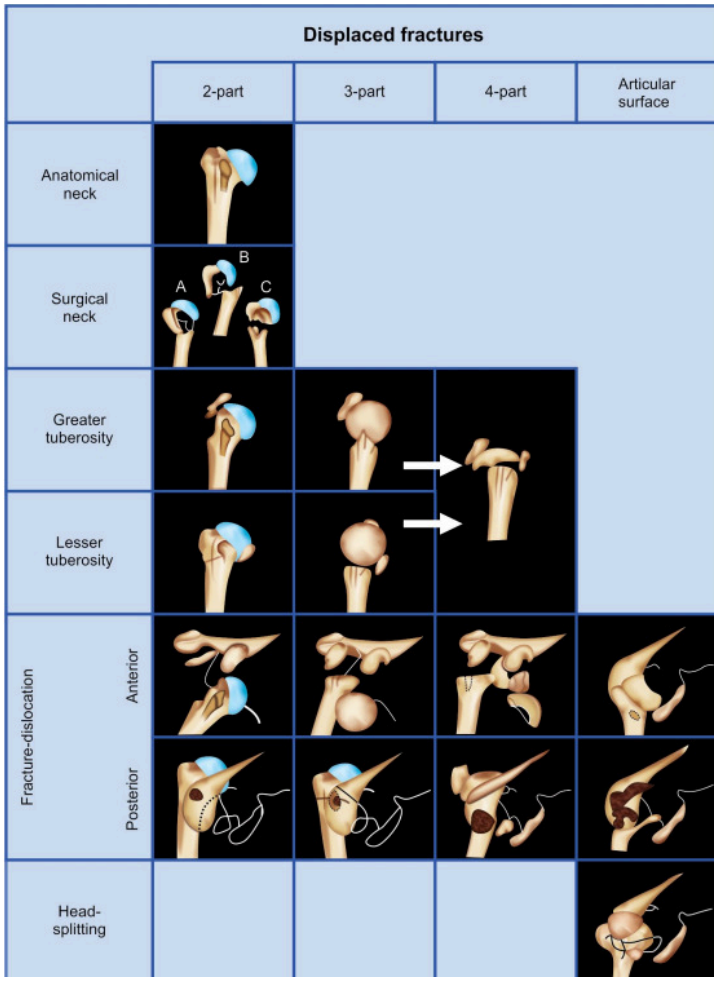

Figure no 3: Neer's classification system—the most widely used (3)

1.3.6.2 The AO/OTA classification

The AO/OTA classification is based on fracture location, impaction, angulation, translation, fracture comminution, and whether a dislocation is present. These fractures belong to the 11

bone segments and are subclassified into types, groups, and subgroups. Finally, each subgroup fracture is assigned a level of severity.

First Part (Humerus): The first part of the code identifies the bone involved. For the humerus, the code would start with the number "1."

Second Part (Location): The second part describes the location of the fracture within the bone. The humerus can be divided into three main parts: proximal, shaft, and distal. Each part is further subdivided into more specific regions.

Third Part (Fracture Pattern and Severity): The third part provides additional details about the fracture pattern and severity. This part includes subcategories that describe the specific characteristics of the fracture, such as the displacement of fracture fragments, the involvement of nearby joints, and whether the fracture is compound or closed.

For example, a fracture of the surgical neck of the humerus might be coded as "11B2" where:

"11" represents the humerus bone.

"B" indicates the location (surgical neck).

"2" provides additional information about the specific fracture pattern and severity (13).

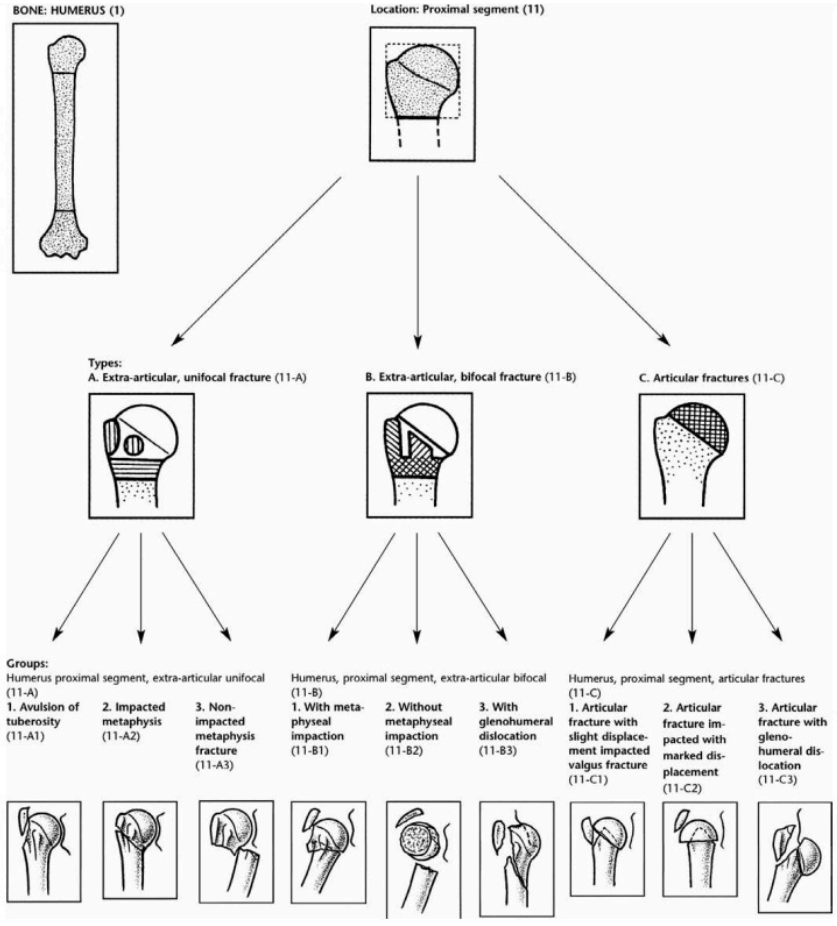

Figure no 4 : AO/OTA classification for proximal humerus fractures (13)

1.3.7 Clinical evaluation

1.3.7.1 Physical examination

Patients who arrive immediately after injury tend to have severe shoulder pain, swelling, and limited shoulder movement, and the arm is held in place with the other hand.

Ecto-ecchymosis does not show up for 24 – 48 hours after injury. However, it may show up within a few hours if high-speed trauma presents more extensive soft tissue damage. It is essential to obtain a comprehensive history of the cause of injury, as indirect violence that causes fractures in the proximal humerus results in a more significant degree of fracture displacement. It is essential to determine whether the cause of injury was a seizure or an electrical shock since these indirect mechanisms lead to posterior dislocation. It is essential to obtain medical history, especially in elderly patients, and to stabilise any problems as soon as possible before continuing with operative management. Palpation of the proximal humerus will cause more pain to the patient. It is imperative to exercise caution when moving the injured shoulder if there is a suspicion of a fracture. Evaluate for associated injuries, especially ipsilateral scapular and rib fractures, and do a pulmonary auscultation to assess pneumothorax and hemopneumothorax. A thorough systematic examination should be conducted to determine if there is any other co-occurrence of shoulder injury.

The most common nerve injury patterns commonly associated with fractures or dislocations of the proximal humerus are isolated axillary nerve and mixed brachial plexus injuries. The most frequent injury related to axillary nerve injuries is an anterior fracture-dislocation with a displaced, more significant tuberosity fracture. The examiner must be aware of potential axillary nerve injury if there is a loss of sensation over the lateral deltoid. Testing for isometric contraction of the deltoid is also recommended. Following axillary nerve injuries, brachial plexus injuries are the next most common. Although vascular injuries are rare, approximately 27% of axillary artery injuries may still have palpable pulses due to scapular collateral circulation. Signs such as associated paresthesias and the development of an enlarging mass should prompt consideration of a vascular injury. The majority of vascular injuries (84%) occur in individuals over the age of 50. If there is an absence or asymmetry of the radial pulse, suspicion of an axillary artery injury should be raised. Fortunately, the viability of the distal limb is typically preserved due to the rich anastomoses between the circumflex scapular artery and the dorsal scapular artery. If a vascular injury is suspected, an angiogram is recommended (3).

1.3.7.2 Radiographic examination

The radiographic evaluation of proximal humerus fractures is essential for diagnosis and a critical factor in assessing possible treatment options. The initial assessment of PHF should include a standard shoulder trauma radiograph series consisting of three views: An anteroposterior view of the shoulder perpendicular to the plane of the scapula, also known as the Grashey view, a Neer view, and an axillary view (13).

During the Grashey view, the patient's torso is rotated 30–45 degrees, bringing the side opposite to the injured shoulder forward. The x-ray beam is thereby aimed perpendicular to the plane of the scapula, imaging the glenoid in profile, and avoiding overlap between the glenoid and the humeral head (13).

Upon the Neer's view examination, with the affected shoulder located against the cassette, the patient's torso is rotated 60 degrees, bringing the side opposite to the injured shoulder toward the source. This gives a view that is perpendicular to Grashey's view (13).

During the axillary view, the arm is abducted as much as possible, with the patient supine and the x-ray beam projected from the axilla onto the cassette located on top of the shoulder (13). Frequently, the patient cannot abduct the arm due to the pain. In such a case, a modified Velpeau axillary view is performed, and the x-ray beam is projected perpendicularly onto a cassette. The patient is asked to lean back and place the shoulder between the X-ray source and the cassette. This can be done with the upper extremity in a Sling (13).

1.3.7.3 Computer Tomography

CT is indicated in rather complex scenarios, particularly fracture dislocations, head-splitting fractures, impaction injuries or associated glenoid fractures, and excessive comminution. It also allows a more detailed understanding of the degree of osteopenia. Three-dimensional reconstruction could be helpful in complex fracture configurations or malunions (13).

1.3.7.4 Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) plays a marginal role in diagnosing proximal humeral fractures. MRI may help confirm a nondisplaced fracture in a patient with shoulder trauma, normal radiographic findings, and clinical symptoms. Furthermore, in fracture dislocations, MRI will allow evaluation of the glenoid labrum and rotator cuff and identify nondisplaced occult glenoid rim fractures (13).

1.3.7.5 Other tests

1.3.7.5.1 Angiography

Vascular imaging is required when there is a suspicion of a vascular injury, such as an asymmetry or absent pulses. Vascular injuries most commonly occur in the third part of the axillary artery, where the vessel is tethered to the humerus by the anterior and posterior humeral circumflex branches. When vascular damage is present, it is often associated with severe medial shaft displacement through a surgical neck fracture (13).

1.3.7.5.2 Ultrasound

US is a valuable modality for the diagnosis of occult proximal humeral fractures. It also plays a role in diagnosing rotator cuff tears in nondisplaced fractures. For the US, however, it may not be possible to achieve maximal internal rotation because of pain (13).

1.3.7.5.3 Densitometry

Dual-energy X-ray absorptiometry may be considered a suitable option for elderly patients with proximal humeral fractures or those with osteoporosis risk factors. As previously mentioned, PHF in the elderly is linked to a higher likelihood of experiencing further osteoporotic fractures. Initiating with a bone density scan would be an ideal starting point for including osteoporotic patients in a fracture prevention program (13).

1.3.7.5.4 Electromyography

Unfortunately, it will not provide reliable results for nerve examinations at the acute stages of trauma. The most appropriate time for nerve study is the subacute stage, approximately three weeks after an injury. EMG may also be used to document the progress of reinnervation (13).

1.3.8 Treatment and management options

The initial aim of PHF treatment is to preserve the physiological AROM of the whole upper extremity and minimise the pain.

Choosing a treatment plan

The approach should be individual when choosing an appropriate treatment plan for each patient. The healthcare professional analysed the following criteria in therapeutic plan determination:

1. Patient characteristics such as age, mental status, genetic factors, family history, substance abuse, medical comorbidities

2. Rehabilitation potential
3. Functional expectations

For example, older patients with a non-active lifestyle and comorbidities prefer to be treated with a non-surgical approach in order to minimise infection risks, have time to rehabilitate, and go back to their previous condition and get rid of the pain. Around 75% of all PHFs happen to be in patients over the age of 60 years as a result of height falls. Such a demographic tends to have non-displaced fractures or minimally displaced, which is suitable for non-surgical treatment. On the other hand, younger individuals sustaining the same fracture are more likely to have it as a result of motor vehicle accidents, seizures, electric shock, and falls from more significant than a standing height. These types of injuries tend to have displacement, fracture of multiple segments, and neural, vascular, or soft tissue damage; hence, a surgical approach is required in such cases (3).

1.3.8.1 Non-surgical treatment options

Stable nondisplaced or minimally displaced proximal humeral fractures can be reliably treated nonoperatively. A high union rate with satisfactory functional outcomes can be achieved. Typical non-operative treatment consists of shoulder immobilisation with a sling. Immobilisation of the arm to the chest using a simple collar and cuff sling, Gilchrist or Velpeau type shoulder immobiliser is generally well tolerated by patients (13).

Figure no 5: Gilchrist Bandage (60)

It is recommended that a pad be placed in the axilla to assist in aligning the fracture due to the tension of the pectoralis major tendon on the proximal shaft segment. Regular follow-up is essential for monitoring the alignment and stability of the fracture, regardless of the nonoperative treatment approach used. Weekly radiographs should be taken in the first month of treatment, followed by biweekly radiographs until six weeks after injury or when initial

callus formation is evident. Final radiographs are typically done at three months to confirm bone union. Shoulder immobilisation is recommended for 4 to 6 weeks following an injury. Right from the start, patients are advised to engage in active range-of-motion exercises for their wrists and hands. Typically, pain subsides within two weeks, allowing for passive range-of-motion exercises for the shoulder. It is recommended to perform these exercises four to six times daily with the assistance of a helper. An initial session with a physiotherapist can be beneficial in guiding the patient on how to perform the exercises correctly. The extent of allowable motion will depend on the stability of the fracture. Ideally, patients should aim to achieve 90 degrees of forward elevation and rotation, starting with the hand placed on the chest and moving towards a neutral position with the hand pointing forward. During the initial 2 to 3 weeks, performing passive range-of-motion exercises while lying down is generally more comfortable. As the patient adapts to these exercises, they can be continued in the sitting or standing position, with a gradual increase in several repetitions or decreased break periods in between exercises. Once a bony union is achieved, healthcare professionals initiate active-assisted range-of-motion exercises at six weeks, followed by the start of strengthening exercises three months after the injury, based on radiographic and clinical healing.
Outcome: Court-Brown et al. conducted a study on 131 surgical neck fractures with two parts in patients. After a year of observation, it was concluded that patients below 50 consistently attained better functional scores and could resume shopping and housework. Nonoperative treatment produced results comparable to surgical treatment, even in fractures with a translation of 66% or more. Despite the overall favourable outcomes, recent data suggests that marked functional impairment may occur, with over two-thirds of patients disclosing chronic pain (13).

1.3.8.2 Surgical treatment options

Two surgical approaches are commonly used to perform open reduction and internal fixation (ORIF). These are the deltopectoral approach and the deltoid-splitting approach.

1.3.8.2.1 Deltopectoral approach provides access to the proximal part of the humerus, including the greater and lesser tuberosities, allowing for the reduction and fixation of the fracture. During the surgery the patient is typically positioned in a semi-sitting or beach-chair position. The affected arm is abducted and externally rotated to allow for better access to the proximal humerus. Advantage of this approach is lowering the risk of injury to the axillary

nerve or deltoid muscle damage and the disadvantage of it reaching the displaced greater tuberosity fragment is more challenging (3).

1.3.8.2.2 Deltoid-splitting approach involves splitting the deltoid muscle fibres to gain access to the fractured area of the humerus. The deltoid-splitting approach has two major disadvantages.In anteroinferior fracture dislocations, the humeral head fragment may not be accessible through this approach. In addition, the terminal anterior branch of the axillary nerve may be inadvertently damaged thereby leading to potential deltoid dysfunction (36).

1.3.8.2.3 Percutaneous Pinning. It involves the insertion of pins or wires through the skin and into the fractured bone fragments to stabilise the fracture and promote healing. Risk of such an intervention may include infections at the pin sites and injury to the nerves or tendons caused by the pins (26).

1.3.8.2.4 Shoulder joint arthroplasty

Hemiarthroplasty is a surgical procedure in which the damaged or fractured head of the humerus is replaced with a prosthetic component while the native glenoid is preserved. It is indicated when the humeral head is deemed unreconstructable, or its biological viability is likely to be severely compromised. Comminuted head-splitting fractures and head depression fractures involving more than 40% of the articular surface are frequently considered to be unreconstructable. The main challenge with this approach is the unpredictability of the outcome. For the optimal result, reduction of the tuberosities and restitution of the correct head-to-tuberosity height needs to be done (13).

1.3.8.2.5 Reverse total shoulder

It is a type of shoulder replacement in which the glenohumeral joint's standard ball and socket relationship is reversed, creating a more stable joint with a fixed fulcrum (59). RSA is a procedure that allows rotation at the glenohumeral joint without relying on a functional rotator cuff/tuberosity unit. This is achieved by placing a hemisphere on the glenoid surface and a concave tray on the humeral stem. Additionally, medializing the centre of glenohumeral rotation improves the biomechanics of the deltoid muscle, enhancing shoulder elevation. Therefore, reverse total shoulder arthroplasty provides an alternative for complex acute proximal humeral fractures and cases of proximal humerus malunion or nonunion where restoring the normal anatomy of the tuberosities is not feasible. It has been suggested that

rehabilitation after reverse total shoulder arthroplasty may be quicker than hemiarthroplasty. This is because the implant stability and lack of importance of tuberosity healing allow patients to regain an earlier active range of motion (13).

Figure no 6: Reverse total shoulder arthroplasty- Radiographic follow-up 5 months after surgery in 80-years-old female patient (13)

1.3.9 Possible complications

1.3.9.1 Neurovascular injuries

Neurologic and brachial plexus injuries occur in up to 8% of all proximal humerus fractures. Anterior fracture-dislocations may injure the axillary nerve (39). The risk of nerve injury is increased in elderly patients, fractures at the collum chirurgicum, dislocation, blunt trauma with associated hematoma, and failed ORIF. It is imperative to remain lateral to the coracoid during surgery, as it is an essential reference point for the shoulder dissection. If a medial dissection is performed, there is a risk of injuring the musculocutaneous nerve, which is located just below the coracoid and enters the coracobrachialis approximately 1.5-2 cm from it (4).

1.3.9.2 Frozen shoulder

This phenomenon can occur after both surgical and non-surgical management. Risk factors include the severity of the initial injury, prolonged immobilisation, articular surface malunion, and noncompliance with rehabilitation. It shows the importance of on-time physiotherapy intervention. A delay in adequate stretching may require surgery to release possible adhesions (3).

1.3.9.3 Avascular necrosis

This complication may be observed in approximately 14% of three-part fractures treated with closed reduction and up to 34% of four-part fractures. This complication is known to cause discomfort and limited range of motion in the shoulder, and in some cases, it may necessitate the need for total shoulder arthroplasty (7).

1.3.9.4 Malunions and nonunions

Malunion refers to the incomplete or improper healing of a fractured bone, resulting in the bone healing in a misaligned or abnormal position. Greater tuberosity malunions happen due to the pull of the rotator cuff. Displacement is superior if only the supraspinatus is affected. Union at this site may cause impingement syndrome. Displacement is posterior if the pull is predominately infraspinatus. Union at this site usually results in posterior impingement against the glenoid, resulting in decreased external rotation. Tuberculum minus malunions are typically very rare. Surgical neck malunions and three-part fractures may be multiplanar with rotation, flexion, and extension combinations. The surgical neck is nonunion and is treated by bone grafting with stabilisation by an ender rod-wire construct. Both malunion and avascular necrosis of the humeral head in three and four-part fractures usually require prosthetic replacement. In the majority of cases, post-traumatic arthritis is present on the glenoid surface (3).

In addition to the complications mentioned above, it is important to consider potential issues such as rotator cuff injuries and dysfunction, injuries to the long head of the biceps tendon, missed posterior dislocation in patients with lesser tuberosity fractures, adhesive capsulitis and scar tissue, posttraumatic arthritis, and the risk of infection (14).

1.3.10 Pharmacotherapy

Regarding the proximal humeral fracture, the only type of medication used (especially after the post-operative approach) is analgesia. Painkillers are divided into local and systemic. Local painkillers target pain at a specific site by blocking nerve signals or reducing inflammation in the area where they are applied. Systemic painkillers, on the other hand, are medications that are absorbed into the bloodstream and act on pain signals throughout the body. Examples of local painkillers are topical, such as patches, creams, and gels containing the active ingredient lidocaine, which is the most well-known. Lidocaine can also be injected, which results in complete blockage of pain signalling. Systemic painkillers include NSAIDs

(nonsteroidal anti-inflammatory drugs) or more robust, such as opioids, for moderate to severe pain management.

Patients are also prescribed antibiotics right after the surgery to decrease the risk of infection. Doctors often prescribe anticoagulants to prevent deep vein thrombosis and pulmonary embolism if the patient is at increased risk of blood clots (37).

1.4 Rehabilitation

According to Bastlova (2004), the whole course for rehabilitation for PHF can be divided into 4 phases:

1. Subacute phase- prevention of reflexive and dystrophic changes. This phase begins in the second week and focuses on C and Th spine segmental mobility and their straightening.
2. Mobility restoration in the scapulo-thoracic articulation. The gradual ending of immobilisation characterises this phase. The goal is to restore the correct function of the scapula and its surrounding muscles. They include tendons and muscles surrounding the lower scapular angle. The focus is on soft tissue mobilisation of muscles attaching to the spine and the superior angle of the scapula. In this period, physiotherapists can use phase I of Vojta's reflex rolling, which decreases tension in the muscles mentioned above and increases the tone in the trunk, spine, and scapular stabilisers muscles. We can also use the Proprioceptive neuromuscular facilitation method, which is beneficial for the rhythmic stabilisation of scapular muscles.

Active arm exercises are encouraged 2-3 weeks after the surgery/injury (of course, about the patient's condition). The patient is shown Codman's pendular exercises (13). The patient is instructed to lean forward while standing. The upper extremity can then dangle from the shoulder, assisted by gravity. As much as 90 degrees of forward shoulder elevation can thereby be achieved. The upper extremity is then passively moved by circularly turning the trunk, letting the arm dangle like a pendulum. Due to long-term immobilisation, the anterior and posterior axilla and biceps of the brachii muscles become shortened. It can be treated with the PNF technique, which includes stretching or Post-isometric relaxation with stretching, acc. to Janda. Any technique with neurophysiological principles will help with muscle shortness. In contrast, muscles such as triceps brachii or external rotators are consistently found to be hypotonic and inhibited. Thus, rehabilitation in the 2nd phase is focused on active external rotation.

1. Neuromuscular stabilisation of the glenohumeral joint. Movements in the open kinetic chain are continued in the form of pendular movement and exercises in closed kinetic chains, in which axial loading through the humerus is gradually increased. "Dosage" can be adjusted by the patient by choosing the amount of weight he can bear during closed chain exercises.
2. Rehabilitation of specific motor skills of the shoulder girdle. This more or less intensive phase begins in non-complicated and early rehabilitated patients at the end of the first month after the injury/surgery. This phase aims to work on active elevation and abduction to at least 135 degrees with adequate scapular ROM. The exercises include practising the stabilisation function through support and training the muscle's ability to alternate its concentric and eccentric activity either by slow reversal of the antagonist or by plyometric exercises. This can be done using elastic bands or throwing balls of different weights against the wall.

Usually, it takes 3-4 months of intensive rehabilitation to achieve satisfactory outcomes after the PHF injury/surgery. However, rehabilitation does not stop at the hospital. The patient is instructed to perform exercises at home and given instructions according to his current condition. Patients can be referred to spa rehabilitation centres for intensive everyday physiotherapy (29).

1.4.1 Therapeutic approaches and procedures used in special part

First and foremost, early physiotherapy intervention shows a significant advantage compared to the delayed onset of rehabilitation, particularly in the range of motion (38).

1.4.1.1 Post isometric relaxation

Post isometric relaxation acc. Lewit (29) has demonstrated long-term effectiveness compared to static stretching in reducing pain and disability. The role of post-isometric relaxation as a manual therapy was proven to relax and lengthen muscles, improving joint motion (2). In addition to treatment for hypertonic muscles, using the PIR technique, dynamic stretching has been proven to increase ROM and decrease passive stiffness sustainably, which is one of the main goals after long-term immobilisation (22).

1.4.1.2 Soft tissue techniques

Soft tissue techniques combined with massage have also been proven to regain the active range of motion in the shoulder joint (56). Joint mobilisation has also been shown to bring positive outcomes in frozen shoulder patients when combined with active exercises to increase range of motion and function (9). Hence, we can apply joint mobilisation if no

contraindications are present in order to regain access to a bigger range of motion in patients with PHF. Another beneficial technique for post-operative intervention is scar therapy as a subcategory of soft tissue manipulation, which includes using physical therapy modalities, such as laser and manual therapy, like hands-on techniques. The goal of manual techniques is blood circulation in the treated area and preparation for other therapeutic methods and procedures. In standard therapy, according to Lewit, we perform four grabbing techniques. These are "C" and "S" palpation, stretching in the axis of the scar and creasing. These techniques work with the barrier phenomenon and produce subsequent releases (34). Other manual techniques that we can use for scar therapy include a helical movement with the thumb in the scar, a helical movement with the thumb approx. 2 cm in circumference around the entire scar, insertion of the thumbs, and tissue traction in the depth of the scar, fold of the scar between the thumbs and alternating movement of the thumbs against each other in the axis of the scar and fold of the scar between the thumbs and rolling of the scar from side to side (20).

1.4.1.3 Proprioceptive neuromuscular facilitation

Another technique is proprioceptive neuromuscular facilitation (PNF), which Dr. Herman Kabat and Margaret Knott developed. It can be considered an active exercise with resistance if adequate muscle strength is present. PNF involves specific diagonal and spiral movement patterns in all three body planes and stimuli to the neuromuscular trigger potential to enhance musculoskeletal system responses. The goals of the PNF concept are to facilitate the initiation of movement and the learning of a new movement, the possibility of changing the speed of movement, increasing muscle strength, increasing stability, improving coordination and motor control, increasing performance, improving range of motion, ability relaxation, pain reduction. Different diagonals are responsible for a particular muscle activation, and different techniques can be applied to strengthen or stretch the muscle. PNF techniques utilise proprioceptive stimulation to facilitate muscle strengthening or relaxation, making it a common exercise in muscle rehabilitation (10).

1.4.1.4 Gravity eliminated exercises

Another type of active exercise includes active movement with relief, where the influence of gravity is reduced to facilitate movement. Examples include exercises in water, weight-bearing exercises on a sling such as RedCord (Neurac), or exercises in the therapeutic cage. They best reduce the effect of friction during movement, eliminating the limb's weight while the physiotherapist can monitor the movement and correct and repair it if necessary. Exercises with isolated limb or body part support are designed to improve neuromuscular

control, stability, and strength by challenging the body's proprioceptive system. Workout with limb support has also improved shoulder muscle activation levels during closed kinetic chain exercises (40).

1.4.1.5 Gym- machine exercises

It is preferred to different physiotherapeutic programs so patients do not get demotivated by the same set of exercises. Working in the gym on cable press machines can be effective s for muscle strengthening and overall fitness. The research highlights the benefits of power training for the elderly population, noting the effectiveness of seated machine training, such as the chest press, for upper-body strength improvement. It is important to evaluate the muscle group target in advance to gain maximum beneficial effects from chest presses and whole upper body exercises in general (51).

1.4.1.6 Dynamic neuromuscular facilitation

Furthermore, Dynamic Neuromuscular Facilitation (DNS) is another rehabilitation approach that focuses on restoring and optimising the function of the musculoskeletal system through the reactivation of developmental movement patterns (29). Studies have demonstrated that shoulder girdle exercises based on DNS can lead to clinically significant gains in hand muscle strength, indicating the potential of DNS-based exercises for improving muscle strength (28). Based on the preferred muscle groups, the physiotherapist chooses a patient's position where the required muscles will be activated.

1.4.1.7 Open and closed kinematic chain exercises

Lastly, we can incorporate closed and open kinematic chain active exercises into the rehabilitation program. The primary difference between those two types lies in how the distal end of the limb interacts with the environment during the movement. In CKC, the distal end of the limb is fixed or stabilised against a surface and vice versa. CKC exercises involve coordinated motion at multiple joints within a kinetic chain, while OKC exercises focus on isolated motion at a single joint. CKC exercises are typically weight-bearing, while OKC exercises usually do not involve weight-bearing. Furthermore, CKC exercises are often considered more functional because they replicate daily activities or sports movements. In contrast, OKC exercises may focus more on targeting specific muscle groups or rehabilitating injured joints. Lastly, CKC exercises emphasise joint stability and proprioception, while OKC exercises focus more on joint mobility and muscle strengthening. One study has investigated the impact of 8 weeks of closed and open kinetic chain strength training on the torque of elite swimmers' external and internal shoulder rotator muscles. The study found that closed-chain exercises significantly increased the strength, mobility, and function of shoulder muscles

compared to open-chain exercises (46). However, it is wrong to underestimate the benefits of OKC exercises since they can be used on individuals who are not allowed to put full weight on their extremities. Such exercises for PHF can include exercises with a wooden stick. This workout can help a patient increase his active ROM, supporting muscle coactivation in the shoulder girdle while keeping the deep stabilisation system active. It also enhances flexibility, muscle strength, and endurance in healthy individuals by engaging back muscles, abdominal muscles, and overall flexibility, thereby contributing to improved physical fitness (45).

1.4.2 Physical therapy and its modalities

P.T. is part of physiotherapy, using various forms of physical energy to treat and prevent disorders (both structural and functional), mainly of the movement system. It can be divided according to energy (mechanotherapy, electrotherapy, phototherapy, and thermotherapy) or desired effect (myorelaxation, analgesia, myostimulation, antiedemic, or trophotropic). The following modalities of physical therapy can be used in PHF diagnosis (49).

1.4.2.1 Acute stage

This stage spawns from the very onset of the injury to approximately the next 48 to 72 hours. This stage can be characterised by five signs: calor, rubor, tumor, dolor, and functio laesa (31). In this stage, the following PT procedures are indicated

1.4.2.1.1 Negative thermotherapy-cryotherapy

Applying cold to the injury site leads to local vasoconstriction of blood vessels and a reduction in the flow of blood and lymph through the tissues, thus preventing the development of massive swelling or hematoma. Vasoconstriction alternates with short-term vasodilation, after which vasoconstriction occurs again. The body's defence reaction includes the release of endorphins with an analgesic effect and euthanization, which is the response of the adaptation of gamma receptors to increased stimulation of the receptors. The aforementioned analgesic effect is also influenced by vasoconstriction, which has an anti-edematous effect and reduces the occurrence of inflammatory mediators. For therapy, so-called cryo bags are filled with a cryoprotectant solution, which is applied to the affected area for a few minutes, 3-5 times daily.

It is important to note that individuals with peripheral polyneuropathy, spinal cord injury, and multiple sclerosis can suffer from hypoesthesia, which is an inability to feel temperature changes. Their sensitivity is disrupted, so they are at risk of having hypothermic burns (49).

1.4.2.1.2 Galvanotherapy

Galvanotherapy is the therapeutic application of electrical currents using galvanic stimulation. This current type will disrupt the internal environment and cause local pH changes, to which the organism reacts with active hyperemia by releasing the precapillary sphincters. During constant galvanization, a direct current flows throughout the application at the set intensity without changing the polarity. In this phase, the effect of euthanization of tissue capillaries is used; at the same time, there is a faster new formation of capillaries, the conversion of fibrinogen into fibrin, and the minimization of changes from ischemia without mechanical irritation of the tissue.

The treatment parameters are intensity, maximum current density, O.1 mA per 1 cm2 of the application area, electrodes placed transregionally on the shoulder, application 1-3 times a day, and duration 10-15 minutes.

Contraindications include Pacemakers, metal implants, and impaired circulation (49).

1.4.2.1.3 Basset current

The Basset current, also known as Pulsed Electromagnetic Field (PEMF) therapy, is a form of electromagnetism-based therapy that uses low-frequency electromagnetic fields to stimulate biological tissues and promote healing. They are pulsed, sinusoidal, and monophasic with a frequency of 72 Hz. They have been proven to increase the transport of calcium cations into cells and, at the same time, increase the sensitivity of osteoblasts to parathormone. They are used for post-traumatic and post-operative conditions of bone tissues already after fixation has been applied.

TP: applied for 20 to 30 minutes, at first daily, later three times a week. The number of procedures is 10 to 20 (49).

1.4.2.2 Subacute stage

This period of healing starts after the acute stage and lasts for several weeks. During this stage, the acute inflammatory response starts to diminish, and the body initiates the process of tissue repair and regeneration.

1.4.2.2.1 Magnetotherapy

Pulse magnetotherapy utilises electromagnetic fields generated by specialised devices to deliver pulsed or magnetic fields to targeted tissues or body regions. PEMF therapy influences

cellular activities, including cell proliferation, tissue repair, inflammation modulation, myorelaxation, and pain relief.
TP: frequency: 25 Hz, intensity: 10 - 20 mT, application time: 40–90 minutes, frequency of procedures per day: 1-2 (49).

1.4.2.2.2 Diadynamic current
CP, or continuous via dynamic current, is a continuous current with low intensity. It activates the microvascular pump, reducing swelling secondary to analgesia. Using the DF current or via dynamic faradic is effective as it combines alternating current (AC) and interrupts galvanic current. It is primarily used for muscle stimulation, promoting muscle contraction and relaxation, improving circulation, and reducing muscle spasms and pain. It is recommended to be used as a premedication at the beginning of therapy, which increases the absolute intensity of the following used current and, thus, the effect.
TP: frequency: DF—100 Hz, CP—50 Hz, intensity: DF—suprathreshold sensitive (NPS), CP—suprathreshold motor (NPM). Electrodes are placed transregionally on the upper arm. The application time is 1 minute for DF and 5 minutes for CP.
CI: Pacemakers or other implanted electronic devices, pregnancy, epilepsy, and areas of active infection or malignancy (49).

1.4.2.2.3 TENS (transcutaneous electrical nerve stimulation)
Involves the use of a portable device that delivers low-voltage electrical impulses through electrodes placed on the skin. It uses currents whose pulse length is less than 1 ms. The main effect of TENS is analgesic. It is possible to use different types of continuous
TENS continuous presents an analgesic effect based on the principle of code theory.
TP: frequency: 142.9 Hz; intensity: according to VAS; location of electrodes: in dermatome C6—different electrode proximally, indifferent electrode distally; application time: 30-60 minutes.
TENS randomised presents with an analgesic effect based on the principle of the gateway theory of pain.
TP: frequency: 100 Hz; intensity: acc to VAS; electrode placement: transregional application; application time: 6-10 minutes.
TENS burst involves the delivery of bursts of high-frequency electrical impulses followed by periods of no stimulation. Based on the endorphin theory, burst-mode TENS provides a robust analgesic effect without causing accommodation or habituation to the stimulation.

TP: Intensity: according to VAS; frequency of impulses: 100 Hz, frequency 1-10 Hz; placement of electrodes: the differential electrode is applied neurally to the C6 dermatome (point electrode), the indifferent electrode is applied proximally; application time: 30-50 minutes.
CI: pacemaker or implanted devices, pregnancy, epilepsy, active cancer, areas of skin sensitivity or reduced sensation (49).

1.4.2.3 Chronic stage
This period is known as the stage of fibroblastic transformation, and begins approximately on the 30th day after the injury. This period may be accompanied by pain, functional impairment, or may be asymptomatic.

1.4.2.3.1 Laser Therapy
Also known as photobiomodulation therapy, it is a non-invasive form of treatment. It utilises low-level laser or light-emitting diode devices to deliver specific wavelengths of light to targeted tissues. Primary effects include stimulating cellular metabolism and energy production (ATP synthesis), enhancing tissue repair and regeneration, modulating inflammation and immune responses, increasing local blood circulation, reducing pain perception by releasing endogenous opioids, and modulating nerve activity.
In the case of humeral fracture, the laser can be ideally indicated for scar therapy.
TP for scar: wavelength: 800-1000 nm; power density: 0.1 W/cm² to 1 W/cm²; energy dose: 1 J/cm² to 10 J/cm²; duration: 5-10 minutes; frequency: 3 times a week (49).

1.4.3 Occupational therapy
Through meaningful engagement, it is a profession that aims to preserve and use the individual's abilities needed to manage regular daily work, hobbies, and recreational activities for people of any age with different types of disability (physical, sensory, psychological, mental, or social disadvantage). It supports the maximum possible participation of the individual in everyday life while fully respecting his personality and possibilities.
Occupational therapy is focused on self-sufficiency and assessment of its level. In order to adequately evaluate the patient's ability to be independent, there is a functional diagnosis. This includes examination, assessment, and subsequent diagnosis of daily life activities. The Barthel Index is among the standardised objective methodologies for evaluating activities of daily life (55). Statistics indicate a return to the maximum possible function occurs within six

months. It is significantly slower during the next six months, and after two years, it is almost minimal. Therefore, if it is impossible to temporarily achieve complete restoration of function shortly, it is necessary to effectively influence, replace, or altogether bypass the current or permanent deficit of the shoulder and maintain the disorder at an acceptable level for the patient in the everyday activities of the day. OT procedures begin already during the limb immobilisation phase when it is essential to teach the patient to use the compensatory aid and to practise the substitution functions with which he can maintain independence. In the case of fractures of the proximal humerus and injuries to the upper limbs, unwanted flexion often occurs. OT tries to avoid these unwanted substitution mechanisms as well. The key concepts used in occupational therapy for proximal humerus fractures are Brugger, Spiral Dynamics, and sensorimotor stimulation.

In cases of long-term immobilisation or any diagnosis where the upper extremity might be affected, it is vital to work on restoring proper hand and arm function, focusing on fine-hand motorists. OT is crucial for UE rehabilitation due to the everyday usage of the hand in performing ADLs. Tasks such as personal hygiene (brushing hair, teeth, showering, toileting), cooking, and manipulating fine objects (keys, coins) are signs of our independence; hence, they are crucial for a proper rehabilitation plan (58).

1.4.4 Regimen measures

Immediately after the surgery, the extremity is placed in an immobiliser, usually in the position of internal rotation and elbow flexion. Nonetheless, the patient is encouraged to perform isometric contractions of the fingers, hand, and elbow in the next few days after the surgery. Activation of the shoulder begins on the 2nd-4th week post-op, depending on the patient’s condition and the hospital’s guidelines. Activation starts with isometric contraction, followed by a gradual increase of ROM, hence switching to the isotonic type of exercise. Later on, when the patient’s condition improves, a resistance can be added. It is essential to respect the need for extremity immobilisation to avoid complications such as malunion or vascular necrosis. Furthermore, it is important to pay attention to contraindicatory movements, including external rotation, abduction (above a certain degree), and lifting heavy objects for the next 6-8 weeks post-op (33).

1.4.5 Prognosis

The success of the surgery and treatment depended on each patient. It is challenging to measure the effectiveness of any intervention due to patients' different initial physical status,

age, gender, comorbidities, and motivation to exercise. However, overall, the trend shows that in the first six months, the patient has the most progressive positive outcomes in regaining ROM, muscle strength, and functionality. After that time, the improvement rate declined, but it was still positive for up to two years. It is crucial to intervene early in rehabilitation to gain as much strength and functionality as possible. The speed of the healing process declines with age, and the chances for complications, on the other side, rise with the patient's age (35). The type of surgery also influences prognosis. Surgical interventions, such as open reduction and internal fixation (ORIF) with locking compression plates, have demonstrated improved functional outcomes in displaced proximal humerus fractures, especially in elderly and osteoporotic patients (43). While locking plates are commonly preferred for treating these fractures due to better clinical outcome scores, they may be linked to a higher reoperation rate (18).

1.5 Examination, carried out in special part

Of course, the first examination was a medical history collection, which is crucial for presenting the complete clinical picture regarding the diagnosis. It is important not to disturb the patient and to let him speak. As Sir William Olsen, a 19th-century doctor, once said, "Listen to your patient; he is telling you the diagnosis."

Subsequent examinations carried out were static and dynamic postural examinations, in other words, visual inspection of overall patient postural alignments in still and moving positions. It is essential to have an overview of the whole musculoskeletal system because our body parts and muscles are interconnected into chains, and dysfunction or disbalance of one part can lead to pathological findings in the other. Paying attention to the shoulder area and the spine alignment and position of the head and lower extremities is crucial.

Gait is also a part of observation, non-correctional examination because how a patient walks can reveal specific pathological findings (52). Gait is one of the basic movement stereotypes, and one of the main goals of almost every rehabilitation is to restore an optimal and independent gait pattern. Modifying standing and gait examinations, such as the Romberg or Vele test, can reveal a disturbance in balance and stability, a crucial factor of risk fall prevention, especially in elderly patients prone to fractures. Also, it can reveal neurological conditions, such as central neural lesions or damage to the vestibulocochlear (VIII) cranial nerve.

Another critical checkup is anthropometric measurements, which are quantitative measurements of various body parameters, circumference, and extremity length. They are

done to compare, for example, the amount of edema or muscle mass difference on the affected extremity (21).

We also examine joints' active and passive range of motion using a goniometer. It is essential to distinguish in which direction there is a limitation in movement to apply a proper physiotherapeutic technique. Also, we need to recognize the difference between limitations in either active or passive ROM. If the limitation is in active ROM, it can be due to pathological muscle findings; if, however, the limitation is present in passive ROM, it can signify structural anatomical changes (46).

According to Kendall, we can also examine muscle length and strength. The muscle length test is an essential factor in identifying structural changes, which can affect the whole musculoskeletal system, and the strength test shows the tonicity of the muscle and the ability to withstand the external force applied. Janda's functional test also tested muscle strength for comparison and examination of muscles, which are not a part of the checkup of Kendall's protocol (23).

Cyriax described a painful arc pattern and proposed an examination to evaluate pain during active movement against resistance.

Another examination is Janda's essential movement pattern examination, in which the patient is asked to perform a particular movement three times with verbal instructions only, without any correction. Movement stereotypes and muscle synergistic movement are observed. During the movement, the physiotherapist tries to observe as many details as possible, including the overall smoothness of the movement, muscle activation, and possible compensatory movement (24).

Functional ADL and fine motorists are also essential evaluations of the proper activation of the hand and the upper extremities. It gives a broader perspective on whether the patient is independent because the dependency depends on how much hand function you can perform. All everyday tasks determine our ability for self-service and maintenance and directly correlate to our ability to be autonomous. There is a functional test of hand motorics for the assessment, which only gives an orientational perspective of hand function ability (27).

Joint play refers to the passive movements within a joint beyond its active range of motion. It is essential to assess if the joint is blocked or has no restriction. Joint blockage can influence surrounding tissue and its own ROM (34).

Another critical examination that Prof. Lewit assesses is soft tissue examination, which includes an examination of skin and its ability to fold, subcutaneous tissue, fascia mobility, muscle tonicity, and periosteal points. This complex soft tissue examination also helps assess

scar tissue, its depth of penetration into the skin, and the ability to move and fold. It is crucial to assess soft tissue as a part of general physiotherapy evaluation because it plays a vital role in the proper function of the segment and the whole body.

Lastly, neurological examination should be a routine practice of every physiotherapeutic assessment. Patients can technically be at risk of peripheral paresis after the fracture or central lesion after TBI. It is important to rule out neurological signs to create a proper physiotherapeutic plan. Neurologic examination is comprehensive terminology and can be divided into extrapyramidal and pyramidal examinations; there can be tests for deep tendon reflexes, superficial and deep sensations, cranial nerves exam, vestibular apparatus examination, etc. It is essential to be focused on a narrow spectrum of examinations, according to patients' clinical signs and official diagnosis (29).

2 PRACTICAL PART

2.1 Methodology of work

The clinical practice occurred in January 2024 and lasted four executive weeks, five times a week, 4 hours a day. In total, clinical practice lasted 80 hours. It took place in Kladno Regional Hospital with the supervisor of Bc. Tomáš Modlinger. I was given a patient at the end of the first week of my CWP. He was an outpatient, meaning we exercised in “therapeutic boxes.” I had eight therapeutic sessions with my patient, each lasting one hour. At the time I first met my patient, he was 1.5 years after the injury and the surgery, with previous experience in physical therapy regarding his condition. After I was given the patient and his diagnosis (before I got the chance to meet him), I prepared kinesiological examinations that I would do on him and had it approved by my supervisor. The next time I saw him, I devised a short-term physiotherapeutic plan, and my supervisor approved the exercises. The chosen kinesiology assessment and therapeutic modalities were taught to me during the three-year program and are primarily from Czech and American physiotherapists and doctors. Techniques such as PNF acc. to Kabat, DNS acc. to Kolar, STT acc. to Lewit, and many more approaches were used during my therapeutic sessions, which my supervisor in the hospital carefully monitored. I always let the patient know what I am doing and which exercise I plan to do next.

The ethical aspects of the research were approved by the head of the department on 22.01.2024 based on the fulfilled conditions given by the Ethics Committee FTVS UK. The original Application for approval of research ethics in bachelor's theses together with a sample of Informed Consent can be found in the section of Supplement.

2.2 Initial Kinesiological Examination

Examined person: Z.M., male

Year of birth: 1969

Diagnosis:

M96.621-Fracture of humerus following insertion of osteosynthesis (ORIF approach)

2.2.1 Anamnesis

STATUS PRAESENS:

A) Objective: Patient is alert, has clear speech, fully oriented and communicates without a problem

Height: 184 cm

Weight: 96 kg

BMI: 28.36

Somatotype: Endomorph

Blood pressure: 140/80 mmHg

Heart rate: 72 bpm

Respiratory rate: 16 bpm

Dominant limb: Right handed

Assistive devices: Glasses

B) Subjective:

- Chief complaint: Patient experiences pain and difficulty during left arm abduction over 100 degrees and flexion over 90 degrees after a fall, resulting in a closed proximal humerus fracture on 22nd of May, 2022. Furthermore, occasionally, he feels pain around the scar, which is located on the anterolateral part of the proximal humerus. From the patient's words, it is hard to describe pain at rest; the pain is minimal and poorly localised on VAS - 1/10; once the arm is used for carrying or lifting something, the pain increases to 4/10 on VAS, it is sharp and pulling character and appears directly at the joint. Sometimes, when the patient does abduction, he has pain directly at the region of the scar. The patient does not experience any pain at night but claims it is uncomfortable to sleep on his left side. The patient feels better when the arm is left at rest, supported after some load of the left arm

- PA (personal anamnesis): The patient fell from the bicycle on the left shoulder in Croatia on May 22nd, 2022. X-ray showed a closed proximal humerus fracture with posterior caput humeri luxation. The patient has gotten Dessault's Bandage. On May 26th, the patient was administered for a planned operation of ORIF surgery for a proximal humerus fracture, which happened on May 27th.
-Diseases: Borreliosis (2001), COVID-19 (2021)
- FA (family anamnesis): mother- hypertension, father- hypertension and Diabetes mellitus II
- IA (injury anamnesis): car accident in childhood, broken nose (1978), injury of the left knee (1995), luxation of the left shoulder (2007), fracture of the proximal humerus and dislocation of caput humeri (2022)
- SA (surgical history): ORIF surgery for proximal humerus fracture (27.05.2022)
- MA (medical anamnesis): Negates
- AA (allergic anamnesis): Turnip, penicillin
- FA (Functional anamnesis): Partially independent, can perform most of the ADL, cannot manipulate objects or reach for them if they are above the level of his eyes. The compensatory mechanism of wrist flexion is used to avoid motion in the shoulder joint. Overuse of the right arm in order to compensate for the movement of the left arm
- SA (social anamnesis): Lives with his wife in a family house without an elevator, no pets at home
- OA (occupation anamnesis): before an injury- administrative work (working on a computer), after an injury- unemployed (unemployment benefits)
- Sport, regular physical activity (past, actual): The patient used to do athletics and basketball in childhood. After that, he was riding a bicycle every week. Post-injury, he rides a bicycle a couple of times a month and goes on two-hour walks a couple of times a week
-Previous physiotherapy: on and off psychotherapeutic sessions and hospitalisations since the injury- therapeutic PE (like for TEP of the shoulder joint; 20 minutes/every), conditional exercises(20 minutes/every day), CPM machine (20 minutes/every day), lymphatic massage(10 minutes/2 a week), arm, back and neck massage(30 minutes/2 times a week), hydrotherapy (hot tub; 30 minutes/2 times a week), exercises in the small pool (back and UE;30 minutes/2 times a week). Physical therapy- Russian stimulation 50 Hz
- Hobbies: walking, bicycle
- Diet: no specific diet
-Abuses: negates

2.2.2 Musculoskeletal examination:

Postural examination (static)

Plumb line test

2.2.2.1 Anterior view

The Plumb line goes in the middle of two feet symmetrically: symphysis pubis, umbilicus, and the midline of the sternum. The base of support is broad but stable; the centre of gravity is placed within the base of support. Weight is applied equally, and overpronation (pes planus) is absent. Proportional arch and angles of the feet, pointing slightly outward (externally rotated). Knee joints are on the same level, with slight external rotation. Toes are not crawled. Patellas are located on the same level and are of the same size. The contour of the medial and lateral calf muscles is equally symmetrical, without abnormal muscle change and visible deformities. The pelvis is symmetrical, and SIAS are on the same level. No shortness of LE was observed from the plumb line test. Abdominal muscles are poorly activated due to the bulging of the stomach. Thoracobrachial triangles have equal shape. The left nipple is located higher than the right one. The collarbone is misaligned; the right one is in a physiological position, while the AC part of the left clavicle is pointing up (horizontal alignment). The left supraclavicular hole is more prominent and profound than the left one. The shoulder girdle sinister is located higher, compared to the right one. Both shoulders are slightly protracted forward. The left upper limb is slightly pronated; the right one is in the neutral position. Elbows are in slight flexion. The head is in a straight position.

2.2.2.2 Lateral view (Right)

The Plumb line goes through 2cm frontally from malleolus lateralis, right beside the knee cap, in the back of the shoulder joint, and slightly behind the earlobe, passing through the lateral part of the skull. Feet are slightly facing outwards. The ankle joint has no plantarflexion or dorsiflexion, and the feet are pointing outwards. The plumb line passes the contour of the shin. The shin line is symmetrical, not enlarged, and well-aligned. There is no visible hyperextension in the knee joint, and the left knee is not visible from the right side. Thigh muscles are well-aligned, with precise contour, without abnormalities. PSIS appears to be higher than SIAS, which signifies the pelvis misalignment. There is a visible hyperkyphosis at approximately the level of Th 3/4. The right arm is located alongside the body and in slight flexion. The cervical spine is slightly protruded forward.

2.2.2.3 Lateral view (Left)

The Plumb line goes 2cm in front of the malleolus lateralis, right beside the knee cap, in the back of the shoulder joint, and slightly behind the earlobe, passing through the lateral part of the skull. Feet are in a slight outward position. The right leg is not visible from that point of view. PSIS appears to be higher than SIAS—visible kyphotisation of the thoracic spine in the third and fourth vertebrae region. The cervical spine shows signs of protrusion forward.

2.2.2.4 Posterior view

The Plumb line goes in the middle of the feet, vertebral column, subgluteal lines, and os occipital. Eversion of feet- Achilles tendons are straight, without being leaned to some angle. Feet are facing slightly outwards, signifying the whole LE minor external rotation. Popliteal lines are symmetrical on both knee joints; the slope goes from the lateral to the medial aspect of the knee—the precise contour of thigh muscles, no significant difference. Subgluteal lines are located on the same level and have a symmetrical shape. Gluteal muscles show some signs of hypotonus. Slight elbow flexion is visible from the posterior aspect. PSIS are located on the same level, with no signs of pelvic obliquity. Paravertebral muscles are symmetrical; the plumb line goes directly through the vertebral column, and there is no sign of lateral curvature of the spine. The position of the scapula on the left side is slightly higher than the right one. However, the size and shape of the scapula are proportionally equal. The right shoulder girdle is more depressed. Elbows are in slight flexion, with the left arm being slightly pronated. The contour of the nuchal muscles is in a clear, well-aligned position. The head is not tilted in a straight position; the line goes through the occipital bone.

2.2.3 Gait analysis

The patient has a rhythmic walk, equal load on both extremities, a slow gait pattern, and a slightly wider support base. Feet are adequately raised with proper knee flexion. The foot arch is appropriate during the gait. Gait has a physiological toe-off to the mid-swing phase. The first contact happened in the calcaneus's lateral part, and the takeoff phase finished in the big toe. No visible sign of hallux valgus. Feet are placed slightly outward during the complete foot contact. Normal extension of the hip during the terminal stance phase of gait. Symmetrical pelvic movement in anteversion, retroversion, and lateral tilt. Spinal junctions are on the same straight line during the walk—little sign of abdomen muscles involved in walking. Arm swing is proportional; however, it is minimal. The head is facing forward

during the walk. Paravertebral muscles are proportionally active during the gait; the most mobile segment is the Th/L junction. Walking is done without losing balance or coordination.

2.2.4 Specific testing of posture

Romberg Test (I-III)

Romberg test I-negative

Romberg test II-negative

Romberg test III-negative

Single-leg stance test (open and closed eyes)- patient was able to stand on single leg with eyes closed, however failed to perform the same activity with the eyes closed

Trendelenburg sign- negative

Vele Test- grade one, good stability, no clawed or pressed toes.

Modification of standing:

Standing on tiptoes-was able to stand on tiptoes for about 5 seconds; fair ability to maintain balance.

Standing on heels- was not able to stand on the heels for 10 seconds.

2.2.5 Dynamic spine examination

Movement	Mobility
Flexion	Patient did not complain of any pain during the movement. The movement has not started from the head flexion, but rather in the lumbar spine. Thoracic spine was not mobile in the segment of Th 3/7. Distance from the floor was 5 cm. No signs of scoliosis
Extension	Patient did not have any pain during extension, however only minimal movement was observed. Patient's most mobile segment was between L4/S1
Lateroflexion (right)	Patient did not complain of any pain. Physiologic pelvic rotation was visible. Curvature is smooth until Th3 till Th7 segments where the curvature was not seen much. Distance is 30 cm

Lateroflexion (left)	Patient did not complain of any pain. Physiologic pelvic rotation was visible. Curvature is smooth until Th3 till Th7 segments where the curvature was not seen much. Distance is 28 cm

Table no 1: Initial dynamic spine examination

2.2.6 Anthropometric measurements

Length of the Upper Extremity	Right	Left
Anatomical total length	85 cm	83 cm
Length of the humerus	38 cm	36 cm
Length of the forearm	47 cm	47 cm
Length of the hand	20 cm	20 cm
Circumferences of the Upper Extremity		
Circumference of the Upper Arm (relaxed)	35 cm	33 cm
Circumference of the Upper Arm (flexed)	38 cm	33 cm
Circumference of the elbow joint	29 cm	30 cm
Circumference of the forearm	29 cm	31 cm
Circumference of the wrist	18 cm	18 cm

Table no 2: Initial anthropometric measurements (cm)

2.2.7 Examination of Range of Motion according to AMA (American Medical Association)

Shoulder joint				
Norms acc to AMA	Right		Left	
	AROM	PROM	AROM	PROM
S: 50-0-180	S: 50-0-180	S: 50-0-180	S: 35-0-90	S: 50-0-160
F: 180-0-0	F: 180-0-0	F: 180-0-0	F: 85-0-0	F: 160-0-0
R: 90-0-90	R: 80-0-80	R: 90-0-90	R: 40-0-50	R: 50-0-60
Elbow joint				
Norms	Right		Left	
	AROM	PROM	AROM	PROM
S: 0-0-140	S: 0-0-140	S: 0-0-140	S: 0-0-140	S: 0-0-140
R: 80-0-80	R: 80-0-80	R: 80-0-80	R: 80-0-80	R: 80-0-80
Wrist joint				
Norms	Right		Left	
	AROM	PROM	AROM	PROM
S: 60-0-60	S: 60-0-60	S: 60-0-60	S: 55-0-55	S: 60-0-60
F: 20-0-30	F: 15-0-25	F: 20-0-30	F: 15-0-25	F: 20-0-30

Table no 3: Initial AROM and PROM examination

2.2.8 Muscle length test (according to Janda or Kendall):

		Grade	
Length test	Author	Right	Left
Pectoralis major (lower sternal part)	Kendall	No Shortness	Shortness
Pectoralis major (upper clavicular part)	Kendall	No Shortness	Shortness
Pectoralis minor	Kendall	No Shortness	No Shortness
Teres major; latissimus dorsi; rhomboid major and minor	Kendall	Shortness	Shortness
External shoulder rotators	Kendall	Shortness	Shortness
Internal shoulder rotators	Kendall	No Shortness	Shortness
Cranial part of trapezius	Janda	1	2
Levator scapulae	Janda	1	2
SCM	Janda	0	

Table no 4: Initial muscle length examination

2.2.9 **Manual muscle strength test** acc. to Kendall

Movement	Muscles	Grade	
Cervical spine		Right	Left
Anterior neck flexion	longus capitis, longus colli, rectus capitis	4+	4+

Anterolateral neck flexion	SCM, scaleni	4+	4+
Posterolateral neck extension	splenius capitis and cervicis, semispinalis capitis and cervicis, cervical erector spinae	4+	4+
Shoulder			
Flexion	deltoideus, coracobrachialis	5	2+
Extension	deltoideus, latissimus dorsi, teres major	5	3-
Abduction	deltoideus, supraspinatus	5	2+
Extension in abduction	deltoideus	5	3-
Horizontal adduction	pectoralis major	4+	4+
Internal rotation	subscapularis, pectoralis major, latissimus dorsi, teres major	4+	3-
External rotation	infraspinatus, teres minor	4+	2+
Shoulder blade- Scapula			
Adduction	rhomboideus major et minor, trapezius (middle)	4+	3-
Elevation	levator scapulae, trapezius (upper)	5	4
Abduction with rotation	serratus anterior	4	4
Caudally	trapezius (lower)	4+	4+
Elbow			

Flexion	biceps brachii, brachialis, brachioradialis	5	4+
Extension	triceps brachii, anconeus	5	4+
Pronation	pronator teres, pronator quadratus	5	4
Supination	supinator, biceps brachii	5	4
Wrist			
Flexion with ulnar duction	flexor carpi ulnaris	5	5
Flexion with radial duction	flexor carpi radialis	5	5
Extension in ulnar duction	extensor carpi ulnaris	5	5
Extension in radial duction	extensor carpi radialis longus et. brevis	5	5

Table no 5: Initial muscle strength test examination

2.2.10 Active movement against resistance of rotator cuff muscles of the shoulder according to Cyriax

Movement	Right	Left
Against abduction	No pain	Pain
Against external rotation	No pain	Pain
Against internal rotation	No pain	No pain
Against supinated arm flexion (elbow flexed)	No pain	No pain

Table no 6: Initial active movement against resistance examination

2.2.11 Basic movement pattern examination according to Janda

Shoulder abduction- right side without pathological findings, physiological abduction pattern. Patient was able to abduct left arm up to 80 degrees and the movement initially was observed in the upper trapezius and levator scapulae. After 80 degrees of abduction, the patient was performing lateral flexion to the right side and pain occurred.

Modified push up (from the wall) - scapula retracts and protracts in an optimal way. There is no visible scapula alatae during the movement.

Neck flexion- proper neck flexion without SCM taking over the movement. Chin was able to touch the sternum.

2.2.12 Functional movement limitations from ALD

Both hands on the head (flexion + abduction): The left hand was not able to reach the top of the head, only with the help of the right arm. The left hand could maximally reach the level of the mouth without compensatory trunk extension.

Both hands back from below (extension + internal rotation): The patient was able to bring both hands behind his back and touch the region of L1.

Hands behind the head (hair brushing) - the patient could not bring the left arm behind his head.

The patient had no problem with fine motorists. However, he does not usually use the left arm to perform fine motor movements such as opening the door with the key, opening a water bottle, brushing his teeth, or writing since the patient is right-handed. The patient experiences minor difficulties with driving, especially when he must turn the wheel. The patient has no problem during self-feeding; however, he struggles with using cutlery such as knives. The patient also experiences problems getting objects from the top shelf when both hands are required. Furthermore, while dressing, the patient must help himself with the right arm while putting on the coat. The patient has no problem tying shoes, walking independently, and performing ADL.

2.2.13 Joint play examination according to Lewit

Joint		Joint play	Result
	C2/C6	Rotation	Not restricted
		Side bending	Not restricted

		Shifting	Not restricted
	C/Th- Th3	Rotation	Restricted
		Side bending	Restricted
		Shifting	Restricted
1st rib	Right	Neck flexion in lateral rotation	Restricted
	Left	Neck flexion in lateral rotation	Restricted
Scapula	Right	Prone	Not restricted
	Left	Prone	Restricted
AC joint	Right	Ventro-dorsal	Not restricted
		Craniocaudal	Not restricted
	Left	Ventro-dorsal	Restricted
		Craniocaudal	Restricted
SC joint	Right	Ventro-dorsal	Restricted
	Left	Ventro-dorsal	Restricted
GH joint	Right	Craniocaudal	Not restricted
		Ventro-dorsal	Not restricted
	Left	Craniocaudal	Restricted caudally
		Ventro-dorsal	Restricted ventrally
Elbow	Right	Radial	Not restricted
		Ulnar	Not restricted

	Left	Radial	Restricted
		Ulnar	Restricted
Wrist	Right	Dorsal	Not restricted
		Palmar	Not restricted
	Left	Dorsal	Not restricted
		Palmar	Not restricted

Table no 7: Initial joint play examination

2.2.14 Soft tissue examination according to Lewit

Skin	Right	Left
Trapezius	Decreased skin mobility	Decreased skin mobility and increased sensitivity and resistance upon the Kibler's fold
Pectoralis	Decreased skin mobility	Decreased skin mobility
Ventral part of upper arm	Physiological	Decreased skin mobility, increased skin sensitivity and resistance especially in the area or scar
Dorsal part of the upper arm	Physiological	Decreased skin mobility
Ventral part of forearm	Physiological	Decreased skin mobility and increased skin sensitivity
Dorsal part of forearm	Physiological	Decreased skin mobility and increased skin sensitivity
Subcutaneous tissue		

Trapezius	Increased difficulty to create a skin fold	Increased difficulty to create a skin fold
Pectoralis	Able to create skin fold	Able to create skin fold
Ventral part of the upper arm	Physiological	Increased difficulty to create a skin fold, especially around scar
Dorsal part of the upper arm	Physiological	Physiological
Ventral part of the forearm	Physiological	Increased difficulty to create a skin fold, painful upon the palpation
Dorsal part of the forearm	Physiological	Physiological
Fascia		
C/Th junction	Increased fascia resistance in rotation to the right and left	
Trapezius	Increased resistance in caudocranial direction	Increased resistance in caudocranial direction
Pectoralis	Increased resistance in caudocranial direction	Increased resistance in caudocranial direction
Ventral part of the upper arm	Physiological	Increased resistance in caudocranial and rotation directions
Dorsal part of the upper arm	Physiological	Slight increase in resistance in craniocaudal direction
Ventral part of the forearm	Physiological	Increased resistance in caudocranial and rotation directions
Dorsal part of the forearm	Physiological	Physiological

Muscles		
Paravertebral	Increased tonus	Increased tonus
Trapezius	Increased tonus	Increased tonus
Levator scapulae	Physiological	Increased tonus
Pectoralis major	Increased tonus	Increased tonus
Supraspinatus	Physiological	Decreased tonus
Infraspinatus	Physiological	Decreased tonus
Elbow flexors	Physiological	Decreased tonus
Elbow extensors	Physiological	Decreased tonus
Wrist extensors	Physiological	Increased tonus
Wrist flexors	Physiological	Increased tonus
Periosteal points		
C2 process	Physiological	
Rib-sternal junction	Slight increased sensitivity	Slight increased sensitivity
Ribs (horizontally)	Slight increased sensitivity	Slight increased sensitivity
Ribs (vertically)	Slight increased sensitivity	Slight increased sensitivity
AC joint	Slight increased sensitivity	Slight increased sensitivity
SC joint	Slight increased sensitivity	Slight increased sensitivity
Acromion	Physiological	Increased sensitivity
Processus coracoideus	Physiological	Increased sensitivity
Epicondylus medialis	Physiological	Increased sensitivity

Epicondylus lateralis	Physiological	Increased sensitivity

Table no 8: Initial soft tissue examination

2.2.15 Neurologic examination according to Kolar

Sensory function

2.2.15.1 Superficial

Dermatomes (light stroke)- exact same feeling for right and left arm

2.2.15.2 Deep

Position sense is not disturbed on any of the extremities (patient was able to show direction of the movement and in which joint eh movement has occurred)

Stereognosis- Patient was able to describe the shape and size of all objects that he has been given to both hands (pencil, bottle, apple, hairbrush)

Graphesthesia- patient was able to identify all patterns, “written” on the skin on both UE

Tactile discrimination- As the distance between two “needles” was getting smaller(5<cm), the the patient could not identify between one or two “needles” being placed on his dorsal part of both arms. In ventral part of the arm it was identifiable for him

2.2.15.3 Deep Tendon reflexes (1- areflexia, 5-clonus/jerks)

UE	Right	Left
Biceps C5	3	3
Triceps C7	3	3
Radial C8	3	3
Finger jerk C8	3	3

Table no 9: Initial DTR examination

2.3 Conclusion of the initial kinesiologic examination

A 55-year-old patient, after falling from a bicycle in May 2022, had a broken fracture of his left proximal humerus. The surgery consisted of an instalment of the osteosynthesis of the humeral head. At the moment of the examination, the patient was almost entirely self-independent and had only minor difficulties performing ADL, such as using a knife, turning the wheel, and dressing up. The patient complains of pain during the load of left UE, which appears directly at the joint; pain does not exceed 5/10 on VAS.

Upon the postural examination, there was visible left shoulder elevation, with the left clavicle being more rotated, which resulted in its more vertical position. Also, there was visible pronation of the left forearm, and both elbows were slightly flexed. Besides that, the patient has a broader support base with feet pointing slightly outward. However, the gait examination showed no signs of pathology or loss of balance or/coordination, except for limited arm swing and wider BOS. Dynamic spine examination uncovered a particular stiffness and limited mobility in the Th3/7 segment into flexion and both lateral flexions, which could be due to disturb activation of upper arm muscles, resulting in consequential decrease ROM in the spine. Anthropometric measurements expressed a 2 cm shortness of the left arm, compared to the right, and decreased circumference of the humerus, significantly when flexed, and oppositely increased forearm circumference as he uses wrist motion to compensate for limited active ROM in the shoulder joint. Active ROM was particularly limited to external rotation, flexion, and abduction, mainly due to muscle weakness. Length test expresses a particular difference if the right and left sides are to be compared, with the left side expressing marked shortness of most muscle groups. Muscle strength tests showed particular weakness in the same muscle groups responsible for external rotation, flexion, and abduction, the main movements to which AROM was limited.

Furthermore, the painful arc was felt in those exact movement patterns. Basic movement pattern examination also showed pathological muscle activation during arm abduction, which contained lateral flexion at the end of the maximum possible movement. Joint play examination has shown restricted patterns on the left side in most joints, such as the C/Th spine, first rib, shoulder, scapula, clavicular joints, and elbow. The reason for joint blockages arises from neurophysiological changes of movement patterns, which in return provokes reflexive changes in the whole body, resulting in joint blockages. Upon soft tissue examination, there was palpable decreased skin, subcutaneous tissue, and fascia mobility and increased resistance on the ventral part of the upper arm, especially around the scar. The scar tissue healed; however, it seemed to be "glued" to the beneath structures and moved poorly in

all directions. There was also increased muscle hypertonus and increased sensitivity upon palpation of the wrist extensors muscle, as the patient uses wrist movement to overcompensate for lack of shoulder AROM. Also, hypertonicity was found in muscles such as the pectoralis major at minor, trapezius, and levator scapulae.
In contrast, on the other side, decreased tonicity was found in the muscles responsible for external rotation of the shoulder, flexion, and extension of the elbow, which in circumference was proven to be smaller compared to the non-injured side. Painful periosteal points were also present, mainly on the left side. Upon the neurological examinations, there were no abnormal findings in DTR or superficial and deep sensations. The patient claims to have improved shoulder function and mobility since his last physiotherapeutic session and has no significant problem performing ADLs. Since the patient does not work, his main goal is to improve flexion to reach for objects higher than the level of his eyes and get rid of the pain he experiences during the load on the left UE.

2.4 Short term and long term rehabilitation plan

2.4.1 Short-term physiotherapy plan

-Increase active and passive ROM (particularly in flexion, abduction, and external rotation)
-Increase muscle strength, particularly muscles responsible for the abduction, flexion, and external rotation (deltoideus, supraspinatus, infraspinatus, teres minor. Additionally: rhomboid major et minor, latissimus dorsi, teres major, and subscapularis)
-Stretch shortened muscles (teres major, latissimus dorsi, rhomboid major and minor, pectoralis major et minor, shoulder rotator muscles, levator scapulae and trapezius)
-Release soft tissue, trigger points, and hypertonicity particularly around the scar on the anteromedial part of the arm, wrist extensors, trapezius bilaterally, pectoralis major et minor, and paravertebral muscles)
-Improve joint play in restricted areas (C/Th junction bilaterally, left first rib, scapula, glenohumeral joint, acromioclavicular joint, sternoclavicular joint, and elbow)

2.4.2 Long-term physiotherapy plan

-Maintain the short-term physiotherapy plan
-Reach maximum possible active ROM
-Reach maximum possible muscle strength of weakened muscles
-Improve movement stereotype, particularity of shoulder abduction

-Maintain and improve self-independence in daily life (diving, cooking, dressing up)
-Educate about best fitting self-exercises, focused on strengthening and stretching techniques
-Regain pre-injury sport activities/ find an alternative best fitting sport

2.4.3 Therapy Proposal

-Passive movements for ROM
-PIR + stretching for shortened muscles
-STT acc. to Lewit and hypertonic muscles and restricted fascia
-Joint mobilisation acc. to Lewit
-Scar therapy (C and S waves, soft ball technique acc. to Jebava)
-PNF second flexion and extension acc to Kabat
-Analytic exercises in the cage with exclusion of gravitation (for muscle strength 2/2+)
-Exercises in the gym on: cable machine and shoulder press machine
- DNS 3-month prone position, DNS 7-month quadruped and DNS 7-month position side sitting- forearm support
- Active exercises

2.5 1st Therapeutic unit (22th January 2024) 60 minutes

The patient has already been attending physiotherapy as an outpatient two times a week for 30 minutes for one consecutive week. Our first kinesiology examination was performed on January 19th, 2024, and the first therapeutic session was performed on January 22nd.
Subjective: The patient's outlook towards his physiotherapeutic sessions is notably positive, even though he harbours some uncertainty about their potential to improve his current state. He reports experiencing pain directly at the shoulder joint, which intensifies during load or when performing external rotation, flexion, and abduction over his ROM. The patient acknowledges minor difficulties in his day-to-day tasks, such as turning the wheel while driving, using cutlery, and reaching for something from the top shelf. However, he remains unfazed, as he can manage these tasks with his dominant (right) limb and has the flexibility to dedicate more time to exercise due to his current work situation.
Objective: The patient cooperates and is oriented with no problem. He has some minor difficulties while undressing and dressing up but is significantly adjusted to it. Otherwise, no pain was experienced upon his arrival at therapy.

2.5.1 Goal of today's therapy session

-Find out patient's main concern and goal regarding his diagnosis

-Apply therapy to increase ROM of shoulder joint

-Strengthen weakened muscles

-Stretch shortened muscles

-Improve scar mobility

2.5.2 Proposed therapy

-Provide STT to hypertonic muscles

-Provide scar therapy (S, C wave)

-Use PNF second flexion and extension for muscle strength

-PIR+ stretch for shortened muscles

-Provide passive movements in the shoulder joint

-Exercise with a stick

2.5.3 Procedures

-Scar therapy- C and S shape waves, apply slight pressure directly on the scar, and use the "soft ball" technique, according to Jebava. Show the patient self-treatment for the scar that he can practise at home. 5 minutes

-Soft tissue technique acc. to Lewit for left upper arm, forearm, pectoralis, and bilateral trapezius C/Th junction. 10 minutes

-PIR with stretching for pectoralis major, external, and internal shoulder rotators, trapezius, and levator scapulae. 10 minutes

-Passive movements of the left shoulder joint in a supine position into flexion, extension, abduction, and external and internal rotations. 10 minutes

-Proprioceptive neuromuscular facilitation- second flexion and extension with slow reversal technique, mainly focusing on external rotators of the shoulder joint. Four times repetition of each diagonal. 10 minutes

-Exercises with a wooden stick. The patient exercised in a sitting position, grabbing a stick on the level of his shoulders; the forearm is in pronation, and the elbow is extended. The patient does flexion of both arms at the same time while holding a stick and does ten repetitions. The following exercise is with the elbow 90 degrees flexion and forearms fully supinated. In this position, he grabs a stick and performs a lateral shift, meaning externally rotating one shoulder and internally the other. The patient had to have his arms close to the body and not

let them move away. The patient performed it ten times on one side and ten times on the other. The last exercise was with elbows extended and forearms pronated (like in 1st exercise), but unlike in 1st exercise, the patient performed circulatory movement for as much as his ROM allowed him. The patient performs ten circles on one side and ten on the other. Working out with the stick took 15 minutes in total

2.5.4 Subjective result

Patient felt confident while performing all of the exercises, since it was not his first physiotherapeutic session. Patient complained of the pain VAS 6/10 during passive flexion of shoulder over 150 degrees, abduction over 120 degrees and external rotation over 40 degrees, but it was tolerable. Patient also complained of the pain during 2nd extension diagonal and unpleasant sensation upon trapezius and wrist extensors palpation.

2.5.5 Objective result

Once the patient left pain or had to increase his load during the active movement or PNF, his face would immediately turn red since he was also trying to hold his breath. Hence, there were some minor breaks in between the exercises. When performing passive flexion and abduction over 100 degrees, some clicks could be heard, and some unsmooth movement patterns could be felt under the fingers; this is when the patient was visibly in pain, holding his breath. During the exercises with the stick, the patient could not perform full arm flexion without slight trunk extension, which had to be corrected, and the whole circle was also challenging for him, as he could not perform an entire circular movement. During the external rotation of the left shoulder and internal rotation of the right one with the stick exercise, the patient was not correctly holding a flexed elbow close to his body, making the movement not a proper external rotation. The patient had to be corrected several times; otherwise, he cooperated well and knew how to exercise and why those exercises were essential for his condition.

2.5.6 Self Therapy

-Scar care. Perform C and S waves on the scar with a healthy arm. 5 minutes
-Perform self massage on wrist extensors, especially on the belly of the muscles, where trigger points are located

-Active movements in laying, sitting and standing of arm flexion, abduction and external rotation (could add a stick, if he has at home) in order to maintain muscle strength
-Stretching of shortened muscles such as pectoralis major and trapezius

2.6 2nd Therapeutic unit (24th January 2024) 60 minutes

Subjective: The patient complained of minor pain directly at the shoulder joint 3/10 one day after our first therapeutic session, as well as some tension in the scar the next day. The patient understands that he will not significantly improve after one session because his problem will last long. Otherwise, the patient was happy with the previous therapy and excited for the upcoming ones.
Objective: No significant changes to the patient's condition were observed

2.6.1 Goal of today's therapeutic unit

-Apply therapy to increase ROM of shoulder joint
-Strengthen weakened muscles
-Mobilise blocked and restricted joints
-Improve scar mobility

2.6.2 Therapy proposal

-Provide scar therapy (S, C wave)
-Use PNF second flexion and extension for muscle strength
-DNS 3-month prone position, DNS 7-month quadruped and DNS 7-month position side sitting- forearm support
-Provide passive movements in the shoulder joint
-Joint mobilisation acc. to Lewit

2.6.3 Procedures

-Scar therapy: C and S shape waves, apply slight pressure directly on the scar, and use the "soft ball" technique, according to Jebava. Release tension and mobilise surrounding soft tissues with a softball. 5 minutes
-Passive movements of the left shoulder joint in a supine position into flexion, extension, abduction, and external and internal rotations. 10 minutes

-Proprioceptive neuromuscular facilitation- second flexion and extension with slow reversal technique, mainly focusing on external rotators of the shoulder joint. Four times repetition of each diagonal. 10 minutes

-Mobilisation techniques 15 minutes

C/Th junction in the direction of dorsal shifting, side-bending, and rotation bilaterally, all done in a sitting position

Mobilisation of the first ribs in sitting

Unspecific mobilisation technique of left scapula in the prone position

Mobilisation of left acromioclavicular joint in ventro-dorsal and craniocaudal directions in supine position

Mobilisation of left sternoclavicular joint in ventro-dorsal and craniocaudal directions in supine position

Mobilisation of the left glenohumeral joint caudally and ventrally in a sitting position

Mobilisation of left elbow joint in radial and ulnar directions in sitting position plus the distraction of the elbow

-DNS- Exercise on the mat and the floor. 20 minutes

3-month prone position. The patient is prone with his shoulders flexed, abducted, and internally rotated with full support on the forearm. The patient is instructed to straighten his spine and ensure his head is in the same line as his spine (not flexed or extended). At the same time, the therapist places his fingers on the patient's elbow joints and asks him to resist slight pressure, simultaneously lifting the chest and abdomen. In such a position, the patient holds for 20 seconds. Three times repetition in total

7-month quadruped. The patient is on all fours (a static form of crawling). His knees and hips are in 90-degree flexion, and his legs are straight and parallel. The spine is straight without performing hyperextension or flexion, and the head is in one line with the spine. Shoulders are not elevated, and arms are straight. Weight is equally distributed along the whole palm and fingers. The patient is then asked to shift his weight slightly forward, putting more pressure on his upper body. The patient is held in such a position for 20 seconds and then relaxes and is released from such a position. Three times repetition in total.

7-month position side sitting- forearm support. The patient is in a side-lying position on the left side, fully supported by the left forearm, including the whole surface of the palm. The lower leg is in complete contact, and the knee and hip are approximately 90 degrees of flexion. The upper leg has complete contact of the foot with the floor, and the upper arm stretches out and " reaches forward." The patient is asked to "fall backward" and apply

pressure to the lower arm (the left shoulder performs more flexion, and the left shoulder does extension) while the upper arm is still reaching out to the front. The patient does this movement three times.

2.6.4 Subjective result

During scar therapy patient could feel resistance and tension directly at the scar. Patient feels more “freedom” in his shoulder joint, especially after performance of passive movements and PNF techniques. Patient does feel slight discomfort and a bit of pain 3/10 right after the 60 minute therapy session. Patient claimed that the hardest exercise today for him was to perform was DNS 7 month position and PNF 2nd extension, where he felt the most discomfort and reasonable muscle weakness

2.6.5 Objective result

The patient had redness and warmness around the scar after the scar therapy, which signified improved blood circulation and showed a slight increase in movement. The passive movement showed difficulty performing flexion and abduction over 100 degrees and external rotation over 30 degrees, with noticeable rough movement in the GH joint. After joint mobilisation, there was relief in the SC, AC joint, elbow, and first rib, but not so much in the C/Th junction and GH joint. The patient’s face turned red during PNF, especially when increased resistance against infraspinatus was added. However, the patient was able to perform this exercise with active-assistive movement. The patient had tried DNS positions before, which was not new for him. However, he mostly struggled to hold a static three-month position for longer than 15 seconds, with his face turning red, holding his breath, and shaking the whole left extremity.

2.6.6 Self Therapy

-Scar care. Perform C and S waves on the scar with a healthy arm. 5 minutes
-Active movements in laying, sitting and standing of arm flexion, abduction and external rotation (could add a stick, if he has at home) in order to maintain muscle strength. 20 minutes
-Try to perform DNS position on all fours and hold it for at least a minute in front of the mirror to control his body position. 15 minutes
-Try to perform push up against the wall
-Try and use left extremity more during daily routines e.g. opening the door with a key, brushing teeth, cooking and cleaning

2.7 3rd Therapeutic unit (26th January 2024) 60 minutes

Subjective: After the 2nd therapeutic session, the patient experienced minor pain around the shoulder joint, more on anterolateral part 3/10 on VAS, otherwise he felt more confident driving the car that day. Patient told that he was trying to use his left had as much as possible during his everyday tasks, however the arm became exhausted very soon

Objective: No major changes to the patient's condition since the last visit were observed

2.7.1 Goal of today's therapy session

-Apply therapy to increase ROM of shoulder joint

-Strengthen weakened muscles

-Stretch shortened muscles

-Improve scar mobility

-Mobilise blocked joints

2.7.2 Proposed therapy

-Provide STT to hypertonic muscles

-Provide scar therapy (S, C wave)

-Use PNF second flexion and extension for muscle strength

-PIR+ stretch for shortened muscles

-Provide passive movements in the shoulder joint

-Exercise with a stick

-Joint mobilisation acc. to Lewit

2.7.3 Procedures

-Scar therapy- C and S shape waves, apply slight pressure directly on the scar, "soft ball" technique acc. to Jebava. 5 minutes

-Soft tissue technique acc. to Lewit for left upper arm, forearm, pectoralis, and bilateral trapezius C/Th junction. 10 minutes

-PIR with stretching for pectoralis major, external, and internal shoulder rotators, trapezius, and levator scapulae. 10 minutes

-Passive movements of the left shoulder joint in a supine position into flexion, extension, abduction, and external and internal rotations. 10 minutes

-Proprioceptive neuromuscular facilitation- second flexion and extension with slow reversal hold technique, mainly focusing on external rotators of the shoulder joint. Four times repetition of each diagonal. 10 minutes
-Exercises with a wooden stick. The patient exercised in a sitting position, grabbing a stick on the level of his shoulders; the forearm is in pronation, and the elbow is extended. The patient does flexion of both arms at the same time while holding a stick and does ten repetitions. The next exercise is with the elbow 90 degrees flexion and forearms fully supinated. In this position, he grapes a stick and performs a lateral shift, meaning externally rotating one shoulder and internally the other. The patient had to have his arms close to the body and not let them move away. The patient performed it ten times on one side and ten times on the other. The last exercise was with elbows extended and forearms pronated (like in 1st exercise), but unlike in 1st exercise, the patient performed circulatory movement for as much as his ROM allowed. The patient performs ten circles on one side and ten on the other. Working out with the stick took 10 minutes in total
-Mobilisation 5 minutes
C/Th junction in the direction of dorsal shifting, side-bending, and rotation bilaterally, all done in a sitting position
Mobilisation of left glenohumeral joint caudally and ventrally in a sitting position.
Application of traction technique

2.7.4 Subjective result

The patient felt a release and pleasant stretch during PIR+ stretching, especially for pectoral muscles. He also found soft tissue techniques pleasant, especially on the overused forearm extensors; however, he felt pain upon palpation during the procedure. Passive movements revealed the same difficulties as during the last physiotherapeutic arm flexion and abduction sessions over 100 degrees and external rotation. PNF techniques were well tolerated; however, patients struggled to move against slight resistance. Exercises with the stick were particularly challenging as the patient got tired towards the end of the session and could not perform the movement accurately.

2.7.5 Objective result

The patient's most significant limitations during passive movement were flexion, abduction, and external rotation, as a significant click was heard during the movement, and the movement itself was not as smooth as desired. Upon palpation, trigger points were found

mainly in m. trapezius bilaterally and wrist extensors were painful upon palpation, but after PIR+ stretching and STT, there was a significant release. PNF 2nd flexion and extension were particularly channelling today, as the patient could not resist during slight application of external force. Towards the end of the session, the patient was getting tired and poorly tolerated exercise with a wooden stick, as his movements were not as accurate as shown in the beginning. After C/Th junction mobilisation, there was no more joint blockage. However, the GH joint was still restricted.

2.7.6 Self Therapy

-Patient was shown 2nd flexion and extension diagonals and was instructed to try as much as he can to perform them at home in front of the mirror to control the movement. 3 repetition to each diagonal

-Scar care. Perform C and S waves on the scar with a healthy arm. 5 minutes

-Active movements in laying, sitting and standing of arm flexion, abduction and external rotation (could add a stick, if he has at home) in order to maintain muscle strength. 20 minutes

-Self mobilisation of the GH joint while sitting on the stool with the back of the stool being placed under the injured arm(with pillow). The patient hangs the arm freely, waiting for the "melting phenomena" or simply the feeling of release.

2.8 4th Therapeutic unit (30th January 2024) 60 minutes

Subjective: The patient had a four-day rest from therapy. However, he used his left arm more daily, especially in cooking. Once the arm becomes exhausted or feels "overused," the patient self-massages and stretches some muscles (pectoralis and trapezius). The patient also says that his arm feels more free and relaxed after a hot bath, and he can exercise longer after it. However, the patient claims there were no noticeable changes after three physiotherapeutic sessions.

Objective: The patient is trying to use his left hand more while dressing, undressing, and manipulating doors and other objects. However, it is seen that his ROM and muscle strength have stayed relatively the same so far.

2.8.1 Goal of today's therapeutic unit

-Apply therapy to increase ROM of shoulder joint

-Strengthen weakened muscles

-mobilise blocked and restricted joints

-Improve scar mobility

2.8.2 Therapy proposal

-Provide scar therapy (S, C wave)
-Use PNF second flexion and extension for muscle strength
-DNS 3-month prone position, DNS 7-month quadruped and DNS 7-month position side sitting- forearm support
-Provide passive movements in the shoulder joint
-Joint mobilisation acc. to Lewit

2.8.3 Procedures

-Scar therapy- C and S shape waves, apply slight pressure directly on the scar, and use the "soft ball" technique, according to Jebava. Release tension and mobilise surrounding soft tissues with a softball. 5 minutes
-Passive movements of the left shoulder joint in a supine position into flexion, extension, abduction, and external and internal rotations. 10 minutes
-Proprioceptive neuromuscular facilitation- second flexion and extension with slow reversal hold technique, mainly focusing on external rotators of the shoulder joint. Four times repetition of each diagonal. 10 minutes
-Mobilisation techniques 10 minutes
Unspecific mobilisation technique of left scapula in the prone position
Mobilisation of the left glenohumeral joint caudally and ventrally in a sitting position
Mobilisation of left elbow joint in radial and ulnar directions in sitting position plus the distraction of the elbow
-DNS- Exercise on the mat and the floor. 20 minutes
3-month prone position. The patient is prone with his shoulders flexed, abducted, and internally rotated with full support on the forearm. The patient is instructed to straighten his spine and ensure his head is in the same line as his spine (not flexed or extended). At the same time, the therapist places his fingers on the patient's elbow joints and asks him to resist slight pressure, simultaneously lifting the chest and abdomen. In such a position, the patient holds for 20 seconds. Three times repetition in total
7-month quadruped. The patient is on all fours (a static form of crawling). His knees and hips are in 90-degree flexion, and his legs are straight and parallel. The spine is straight without performing hyperextension or flexion, and the head is in one line with the spine. Shoulders

are not elevated, and arms are straight. Weight is equally distributed along the whole palm and fingers. The patient is then asked to shift his weight slightly forward, putting more pressure on his upper body. The patient is held in such a position for 20 seconds and then relaxes and is released from such a position. Three times repetition in total.
7-month position side sitting- forearm support. The patient is in a side-lying position on the left side, fully supported by the left forearm, including the whole surface of the palm. The lower leg is in complete contact, and the knee and hip are approximately 90 degrees of flexion. The upper leg has complete contact of the foot with the floor, and the upper arm stretches out and " reaches forward." The patient is asked to "fall backward" and apply pressure to the lower arm (the left shoulder performs more flexion, and the left shoulder does extension) while the upper arm is still reaching out to the front. The patient does this movement three times.
-Push up from the wall. The patient is asked to step a maximum of 1 metre away from the wall with his palms on the shoulder level and placed on the wall. The patient is asked to perform slow and controlled elbow flexion and extension movements. The whole arm can be more or less externally rotated depending on the muscles we want to activate and the difficulty level of the exercise. The patient performs 15 push-ups, which take 5 minutes.

2.8.4 Subjective result

The patient could feel resistance and tension directly at the scar during scar therapy. The patient feels more “freedom” in his shoulder joint, especially after performing passive movements and PNF techniques. The patient does feel slight discomfort and a small quantity of pain 2/10 right after the 60-minute therapy session. The patient claimed that the most strenuous exercise today was performing the DNS 7-month position and PNF 2nd flexion and extension, where he felt the most discomfort and reasonable muscle weakness. However, he did not give up and finished the whole therapy as it was planned.

2.8.5 Objective result

The patient had redness and warmness around the scar after the scar therapy, which signified improved blood circulation and showed a slight increase in movement. The passive movement showed difficulty performing flexion and abduction over 100 degrees and external rotation over 30 degrees, with noticeable rough movement in the GH joint. Unspecified scapula mobilisation and mobilisation of the GH joint improved joint play and aided during the therapy, allowing for slightly increased active ROM. The patient’s face turned red during

PNF, especially when increased resistance against infraspinatus was added. However, the patient was able to perform this exercise with active-assistive movement. The patient mostly struggled to perform a dynamic 7-month position for longer than three repetitions, with their face turning red, holding their breath, and shaking the whole left extremity.

2.8.6 Self Therapy

-Scar care. Perform C and S waves on the scar with a healthy arm. 5 minutes
-Active movements in laying, sitting, and standing, such as arm flexion, abduction, and external rotation (he could add a stick if he has one at home), to maintain muscle strength. 20 minutes
-Try to perform the DNS position on all fours and hold it for at least a minute in front of the mirror to control his body position. 15 minutes
-Perform push-ups against the wall as taught during the session. Adjust rotation of the arm, depending on his performing abilities
-Try to use left extremity more during daily routines e.g., opening the door with a key, brushing your teeth, cooking, and cleaning

2.9 5th Therapeutic unit (1st February 2024) 60 minutes

Subjective: Patient claims to have a painful region around his scar 4/10 on VAS. Pain is dull until the whole arm is raised to 90 degrees flexion, when the pain becomes slightly sharper and well localised around the scar region. The patient does not complain of pain during the night; however, it's challenging and time-consuming to activate the left arm during daily tasks. After the last session, the patient did not notice any significant differences in his condition.
Objective: No particular improvement was observed besides more activation of the left hand during dressing and undressing

2.9.1 Goal of today's therapeutic unit

-Apply therapy to increase ROM of shoulder joint
-Strengthen weakened muscles
-Improve scar mobility

2.9.2 Therapy proposal

-Provide scar therapy (S, C wave), application of direct pressure

-Analytic exercises in the cage with exclusion of gravitation (for muscle strength 2/2+)

-Exercises in the gym on: cable machine and shoulder press machine

-DNS 3 month prone position and 7 month quadruped position

2.9.3 Procedures

-Scar therapy: C and S shape waves, apply slight pressure directly on the scar, and use the "soft ball" technique, according to Jebava. Release tension and mobilise surrounding soft tissues with a softball. 5 minutes

-Analytical exercise in the cage is used for left arm abduction, flexion, and extension. The patient is lying supine on the bed in the cage system. His upper arm is supported by a pad attached to a rope and a ceiling(directly above his shoulder joint). His wrist is also attached to the same rope as his shoulder joint, simultaneously connected to a load (1 kg) located across the body on the side of the wall. This analytical exercise allows for bigger ROM due to excluding the gravitational field while still adding a durable load for the patient. The patient performs arm abduction for 10 minutes in full ROM; then, he is turned to the right side to perform hand flexion and extension in full ROM. 20 minutes in total

-Exercise on the cable machine (8 kg load) and shoulder press machine (10 kg load). A cable machine is used for shoulder flexion, extension, and abduction, and a shoulder press machine is used for the pectoralis, triceps, and upper back. Pauses after every ten repetitions, a total of 20 minutes

-3-month prone position. The patient is prone with his shoulders flexed, abducted, and internally rotated with full support on the forearm. The patient is instructed to straighten his spine and ensure his head is in the same line as his spine (not flexed or extended). At the same time, the therapist places his fingers on the patient's elbow joints and asks him to resist slight pressure, simultaneously lifting the chest and abdomen. In such a position, the patient holds for 20 seconds. Three times repetition in total

7-month quadruped. The patient is on all fours (a static form of crawling). His knees and hips are in 90-degree flexion, and his legs are straight and parallel. The spine is straight without performing hyperextension or flexion, and the head is in one line with the spine. Shoulders are not elevated, and arms are straight. Weight is equally distributed along the whole palm and fingers. The patient is then asked to shift his weight slightly forward, putting more pressure

on his upper body. The patient is held in such a position for 20 seconds and then relaxes and is released from such a position. Three times repetition in total. 15 minutes

2.9.4 Subjective result

The patient felt more confident while exercising in the cage since he could perform the movement in a bigger ROM, which gave him more confidence and visibly elevated his mood. He found this exercise interesting, compelling, and less exhausting than, for example, PNF. The patient did not complain of pain during this exercise. During the workout in the gym, the patient tolerated a maximum 8 kg load for the cable machine and 10 kg load for the shoulder press machine. The patient found three months prone and seven months quadruped positions quite challenging and was slightly exhausted towards the end.

2.9.5 Objective result

The patient could exercise in the cage for 20 minutes without any difficulties or pain complaints; even though he could do 1kg of load, he was doing proper movement in the whole ROM. The patient tolerated this exercise well, and it showed him his full potential for the ROM he was aiming for. Exercises in the gym were not so challenging for the patient as he already had experience with them and knew how they worked. The patient only became tired during the three months in a prone position where he was not able to lift off his abdomen and would constantly lift his head. The seven-month quadruped position was also challenging as shaking around the shoulder joint (mainly external rotators) was observed, and the patient's face turned red. Nonetheless, the patient successfully exercised for the 60 minutes we had.

2.9.6 Self therapy

-Scar care. Perform C and S waves on the scar with a healthy arm. 5 minutes
-Stretch shortened muscles PIR (pectoralis, biceps brachii) 5 minutes
-Active movements in laying, sitting, and standing, such as arm flexion, abduction, and external rotation (he could add a stick if he has one at home), to maintain muscle strength. 20 minutes
-Try to perform the DNS position on all fours and hold it for at least a minute in front of the mirror to control his body position. Once the patient can perform such a position, he can then try to lift his knees off the table slightly to work on scapula stabilisers even more. 15 minutes
-Keep using left extremity more during daily routines e.g., opening the door with a key, brushing teeth, cooking, and cleaning

2.10 6th Therapeutic unit (6th February 2024) 60 minutes

Subjective: The patient reported satisfaction with the previous session, particularly enjoying the full range of motion exercises in the cage. He noted a significant difference in his energy levels compared to when he exercised using PNF or DNS approaches. However, he did complain of minor pain at the scar region while loading the left extremity. The pain was well localised, not radiating to any further structures, and he rated it as 3/10 on VAS.
Objective: The patient tries to use his left hand as much as possible during object manipulation or dressing. However, during dressing/undressing, a visible increase in ROM was not noted.

2.10.1 Goal of today's therapeutic unit

-Apply therapy to increase ROM of shoulder joint
-Strengthen weakened muscles
-Treat HAZ and trigger points
-Improve scar mobility

2.10.2 Therapy proposal

-Provide scar therapy (S, C wave), application of direct pressure
-Analytic exercises in the cage with exclusion of gravitation (for muscle strength 2/2+)
-Exercises in the gym on: cable machine and shoulder press machine
-Soft tissue techniques acc. To Lewit

2.10.3 Procedures

-Scar therapy- C and S shape waves, apply slight pressure directly on the scar, and use the "soft ball" technique, according to Jebava. Release tension and mobilise surrounding soft tissues with a softball. 5 minutes
-Soft tissue technique for HAZ located mainly in trapezius bilaterally, levator scapulae bilaterally, pectoralis major et minor bilaterally, shoulder flexors (left), and wrist extensors (left). 15 min
-Analytical exercise in the cage is used for left arm abduction, flexion, and extension. The patient is lying supine on the bed in the cage system. His upper arm is supported by a pad attached to a rope and a ceiling(directly above his shoulder joint). His wrist is also attached to the same rope as his shoulder joint, simultaneously connected to a load (1 kg) across the body on the side of the wall. This analytical exercise allows for bigger ROM due to excluding the

gravitational field while still adding a durable load for the patient. The patient performs arm abduction for 10 minutes in full ROM; then, he is turned to the right side to perform hand flexion and extension in full ROM. 20 minutes in total

-Exercise on the cable machine (8 kg load) and shoulder press machine (10 kg load). A cable machine is used for shoulder flexion, extension, and abduction, and a shoulder press machine is used for the pectoralis, triceps, and upper back. Pauses after every ten repetitions, a total of 20 minutes.

2.10.4 Subjective result

The patient complained of minor pain, approximately 3/10 on VAS, towards the end of the exercises. The patient managed, however, to go through the initial plan and exercised for a full 40 minutes. He enjoys exercising in the cage, which allows him to feel what full ROM perceives. The patient felt increased tension and pain during palpation of the upper trapezius, specifically on the left side, and tightness in wrist extensors on the left side as well; however, after the STT, the patient felt much better, and the pain decreased.

2.10.5 Objective result

Even though the patient managed to go through all the exercises, there has not been much improvement over the last therapeutic exercises. There is still a visible decrease in physiologic ROM of the left shoulder girdle joint and muscle weakness of external rotators. HAZ and trigger points reappear after the procedure, mainly at wrist extensors, trapezius bilaterally, and pectoralis major et minor bilaterally. Otherwise, the patient will be well motivated, accomplish all of the goals, try to use his left arm as much as possible during his ADL, and exercise at home.

2.10.6 Self therapy

-Scar care. Perform C and S waves on the scar with a healthy arm. 5 minutes

-Relax hypertonic muscles with the use of PIR technique (pectoralis major et minor, biceps brachii, wrist extensors, trapezius) 10 minutes

-Active movements in laying, sitting, and standing, such as arm flexion, abduction, and external rotation with a stick or a towel, to maintain muscle strength. 20 minutes

-Perform the second extension and flexion diagonal in lying or sitting without resistance (added load) 3 times for each diagonal. 10 minutes
-Keep using left extremity more during daily routines e.g., opening the door with a key, brushing teeth, cooking, and cleaning

2.11 7th Therapeutic unit (7th February 2024) 60 minutes

Subjective: The patient feels tired, as this is his second therapeutic session. However, he is excited about the upcoming physiotherapy. He claimed that a hot bath really helps him with pain, especially before going to bed, and he uses it once every two days for 20 minutes. After he massages trigger points and painful spots on the belly of the muscle for an additional 10 minutes, it does improve his pain management. The patient, however, has not noticed any improvement in terms of increased ROM or increased muscle strength very much.
Objective: Because the patient massages his problematic and painful spots at home and tries to use his left arm more, there was a significant decrease in tightness of the wrist extensors, and upon palpation, the patient does not proceed to feel as great pain as he used to. However, even though the patient does try to use his left arm more during his everyday tasks, there has not been a noticeable increase in shoulder flexion, abduction, or external rotation.

2.11.1 Goal of today's therapeutic plan

-Apply therapy to increase ROM of shoulder joint
-Strengthen weakened muscles
-Stretch shortened muscles
-Improve scar mobility
-Mobilise blocked joints

2.11.2 Proposed therapy

-Provide STT to hypertonic muscles
-Provide scar therapy (S, C wave)
-Use PNF second flexion and extension for muscle strength
-PIR+ stretch for shortened muscles
-Provide passive movements in the shoulder joint
-Exercise with a stick
-Joint mobilisation acc. to Lewit

2.11.3 Procedures

-Scar therapy- C and S shape waves, apply slight pressure directly on the scar, “soft ball” technique acc. to Jebava. 5 minutes

-Soft tissue technique acc. to Lewit for left upper arm, forearm, pectoralis, and bilateral trapezius C/Th junction. 10 minutes

-PIR with stretching for pectoralis major, external, and internal shoulder rotators, trapezius, and levator scapulae. 10 minutes

-Passive movements of the left shoulder joint in a supine position into flexion, extension, abduction, and external and internal rotations. 10 minutes

-Proprioceptive neuromuscular facilitation- second flexion and extension with slow reversal hold technique, mainly focusing on external rotators of the shoulder joint. Four times repetition of each diagonal. 10 minutes

-Exercises with a wooden stick. The patient exercised in a sitting position, grabbing a stick on the level of his shoulders; the forearm is in pronation, and the elbow is extended. The patient does flexion of both arms at the same time while holding a stick and does ten repetitions. The following exercise is with the elbow 90 degrees flexion and forearms fully supinated. In this position, he grapes a stick and performs a lateral shift, meaning externally rotating one shoulder and internally the other. The patient had to have his arms close to the body and not let them move away. The patient performed it ten times on one side and ten times on the other. The last exercise was with elbows extended and forearms pronated (like in 1st exercise), but unlike in 1st exercise, the patient performed circulatory movement for as much as his ROM allowed him. The patient performs ten circles on one side and ten on the other. Working out with the stick took 10 minutes in total

-Mobilisation 5 minutes

Unspecific mobilisation of scapula join in the prone position

Mobilisation of left glenohumeral joint caudally and ventrally in a sitting position.

Application of traction technique

2.11.4 Subjective result

The patient felt minor pain upon the pressure application directly to the scar, 2/10 on VAS, and the pain was well localised. After the scar therapy, the pain decreased, and the patient felt a "relief" directly beneath the scar. After mobilisation of the scapula, the patient felt slight relief of tension in his back and did not complain of any pain, as GH joint mobilisation showed no signs of pain. During the pectoralis stretch, the patient did feel pleasant tension;

however, they could not perform all three repetitions of the PIR technique, so we managed to accomplish two. The patient again felt discomfort in the shoulder's external rotators; however, after passive movements, it went away pretty quickly. As usual, the most strenuous exercise for the patient was second flexion, emphasising supraspinatus and infraspinatus, where he felt the most weakness in his arm. Exercises with the wooden stick towards the end were tiring for the patient. However, he enjoys exercising with the stick as he can control the movement with the healthy extremities.

2.11.5 Objective result

Whenever the therapy starts with STT, the patient feels tension; however, after some time, there is improved blood circulation, increased local redness, and temperature. As it happens, the scar becomes slightly less stiff and the soft tissue around it more movable, especially m—biceps brachii caput longum. During scapula mobilisation, there was palpable roughness in movement and signs of stiffness and blocked joints, but after the round of mobilisation, it got better and felt freer. GH joint mobilisation showed no particular signs of improvement. During PIR for pectoralis, the patient could not give resistance, so we only used the force of gravity and two times repetition instead of 3. As for the shoulder's external rotators, the patient could not entirely give slight resistance, and we used the force of gravity again. At the beginning of passive movements of the shoulder joint, it feels stiff, and there is a clicking sound and rough area during approximately 100 degrees of flexion and 90 degrees of abduction. This is also the place where the patient feels the most pain during the movement. During the performance of the PNF diagonal, the patient had a hard time performing a hold, especially for the muscles supraspinatus and infraspinatus. His face immediately turns red, and he tries to hold his breath. The movement was not as smooth as expected, and the patient stopped at approximately 90 degrees of shoulder flexion. Exercises with the wooden stick were also quite challenging at the end of the therapeutic session, as the patient could only perform approximately 60% of the whole ROM in the left shoulder joint, flexion, abduction, and external rotation in particular. After mobilisation of the scapula, the patient felt slight relief from tension.

2.11.6 Self therapy

-2nd flexion and extension diagonals, and he was instructed to try as much as he could to perform them at home in front of the mirror to control the movement. Three repetitions to each diagonal for 10 minutes

-Scar care. Perform C and S waves on the scar with a healthy arm. 5 minutes

-Active movements in laying, sitting, and standing, such as arm flexion, abduction, and external rotation (he could add a stick if he has one at home), to maintain muscle strength. 20 minutes

-Self-mobilisation of the GH joint while sitting on the stool with the back of the stool being placed under the injured arm(with a pillow). The patient hangs the arm freely, waiting for the "melting phenomena" or simply the feeling of release.

-Laying on the roll (if unavailable, hard roll from the towel) for scapula and Th spine mobilisation. 5 minutes

2.12 8th Therapeutic unit (8th February 2024) 65 minutes

Subjective: The patient feels stiffness and is slightly tired after having two therapeutic sessions in a row. However, he is excited about his last therapy. The patient, however, claims not to see any significant improvements to his condition. The patient says that self-massage and hot baths help with pain management, and he does it before self-therapy at home to decrease pain during active ROM. The patient claims that he increased his left arm usage during everyday life, especially during food preparation and hygiene.

Objective: The patient's high motivation and optimism are evident, despite the lack of major improvements in his diagnosis. His active participation in his therapy, particularly his efforts to use his left hand as much as possible, is reassuring. This is especially noticeable before the therapy, when he undresses using his operated extremity. However, the range of motion (ROM) remains unchanged from the start of our therapeutic block.

2.12.1 Goal of today's therapeutic unit

-Apply therapy to increase ROM of shoulder joint

-Strengthen weakened muscles

-Decrease tension and release trigger points in soft tissues

2.12.2 Therapy proposal

-Soft tissue techniques acc. To Lewit

-Analytic exercises in the cage with exclusion of gravitation (for muscle strength 2/2+)
-Exercises in the gym on: cable machine and shoulder press machine
-DNS 3 month prone position and 7-month position side sitting- forearm support

2.12.3 Procedures

-Soft tissue technique for trapezius bilaterally, levator scapulae (left), pectoralis major et minor (left), m. biceps brachii, m. coracobrachialis, m. brachioradialis and group of wrist extensors and flexors (m. extensor carpi radialis brevis et longus, m. extensor digitorum, m. extensor carpi ulnaris, m. extensor digiti minimi, m. pronator teres, m. flexor carpi ulnaris et radialis, m. palmaris longus). We control the movement for fascia mobilisation for the lower and upper arms. For trigger points, mainly in the pectoralis, trapezius, and wrist extensors, manual palpation and pressure at one point were used until the melting phenomena occurred. 10 minutes

-Analytical exercise in the cage is used for left arm abduction, flexion, and extension. The patient is lying supine on the bed in the cage system. His upper arm is supported by a pad attached to a rope and a ceiling (directly above his shoulder joint). His wrist is also attached to the same rope as his shoulder joint, simultaneously connected to a load (1 kg) located across the body on the side of the wall. This analytical exercise allows for bigger ROM due to excluding the gravitational field while still adding a durable load for the patient. The patient performs arm abduction for 10 minutes in full ROM; then, he is turned to the right side to perform hand flexion and extension in full ROM. 20 minutes in total

-Exercise on the cable machine (8 kg load) and shoulder press machine (10 kg load). A cable machine is used for shoulder flexion, extension, and abduction, and a shoulder press machine is used for the pectoralis, triceps, and upper back. Pauses after every ten repetitions, a total of 20 minutes

-3-month prone position. The patient is prone with his shoulders flexed, abducted, and internally rotated with full support on the forearm. The patient is instructed to straighten his spine and ensure his head is in the same line as his spine (not flexed or extended). At the same time, the therapist places his fingers on the patient's elbow joints and asks him to resist slight pressure, simultaneously lifting the chest and abdomen. In such a position, the patient holds for 20 seconds with three times repetition in total

DNS 7-month position side sitting- forearm support. 7-month position side sitting- forearm support. The patient is in a side-lying position on the left side, fully supported by the left forearm, including the whole surface of the palm. The lower leg is in full contact, and the

knee and hip are approximately 90 degrees of flexion. The upper leg has full contact of the foot with the floor, and the upper arm stretches out and " reaches forward." The patient is asked to "fall backward" and apply pressure to the lower arm (the left shoulder performs more flexion, and the left shoulder does extension) while the upper arm still reaches the front. The patient does this movement three times.

2.12.4 Subjective result

The patient felt burning pain 2/10 on VAS upon STT, particularly in wrist extensors, upon palpation and trigger point therapy. The patient described stiffness upon head lateral flexion and trapezius palpation bilaterally. The patient enjoys exercises in the cage, as he does not feel pain upon performing full ROM in shoulder flexion or abduction while working with 1 kg of weight. His most challenging exercises were DNS, a seven-month position in particular, where the patient experienced the most discomfort and muscle weakness. The 3-month position was also challenging as he could only hold up to 10 seconds. The patient tolerated machine exercises well and did not complain of any pain.

2.12.5 Objective result

Trigger points were found in the pectoralis major (clavicular head), upper trapezius bilaterally, wrist flexors, and extensors. Restricted fascia was found in the anteromedial and lateral part of the upper arm, around the scar region in particular, and on the anterior and posterior of the forearm. However, after the therapy, the tension of the fascia decreased, particularly in the lower arm, and the trigger points became less palpable and painful. The patient managed to fulfil the whole workout plan for the analytic exercise in the cage and performed it with no problem, as well as exercises on the machines, where, even though the load had not increased since the last therapeutic session, he managed to lift 8 and 10 kg loads. However, when we started to do the DNS 7-month position, the patient’s face was starting to turn red, and he was holding his breath, especially as he was performing a turning movement with his operated arm. This exercise is the most demanding, and the patient cannot perform more than three turns without a break. The three-month position also caused discomfort and visible difficulty, as the patient’s left shoulder shook as he tried to hold this position for 10 seconds.

2.12.6 Self therapy

-Active movements in laying, sitting, and standing, such as arm flexion, abduction, and external rotation (he could add a stick if he has one at home), to maintain muscle strength. If the muscle strength improves, the patient can add a dumbbell of 1 kg at a time. 20 minutes

-Soft tissue technique and trigger point release of hypertonic muscles and highly resistant fascia, mainly on the left upper and lower arm, trapezius, and pectoralis. 10 minutes

--Scar care. Perform C and S waves on the scar with a healthy arm. 5 minutes

-Use Physical therapy (hot bath) for muscle relaxation, blood circulation, and metabolism. Maximum 20 minutes in a hot bath (30-45 degrees Celsius) prior to or after the exercises at home

-Keep using the left upper extremity as much as possible during everyday life, but try not to overcompensate with active wrist movements to avoid overuse of wrist flexors and extensors

- Stretching of shortened muscles (pectoralis major, external shoulder rotators, levator scapulae left unilaterally, and trapezius bilaterally). Leave extremity in a stretched position for 30 seconds

-Closed kinematic chain exercises (DNS 7) months quadruped position. The patient has managed to master such a static position. He can slowly lift the upper or lower extremities, maintaining a still position. Push up from the wall- slow and controlled movement)

2.13 Final Kinesiological Examination

2.13.1 Musculoskeletal examination:

Postural examination (static)

Plumb line test

2.13.1.1 Anterior view

The Plumb line goes in the middle of two feet symmetrically: symphysis pubis, umbilicus, and the midline of the sternum. The base of support is wide but stable; the centre of gravity is placed within the base of support. Weight is applied equally, and overpronation (pes planus) is absent. Proportional arch and angles of the feet, pointing slightly outward (externally rotated). Knee joints are on the same level, with slight external rotation. Toes are not crawled. Patellas are located on the same level and are of the same size. The contour of the medial and lateral calf muscles is equally symmetrical, without abnormal muscle change and visible deformities. The pelvis is symmetrical, and SIAS are on the same level. No shortness of LE was observed from the plumb line test. Abdominal muscles are poorly activated due to the bulging of the stomach. Thoracobrachial triangles have equal shape. The left nipple is located higher than

the right one. The collarbone is misaligned; the right one is in a physiological position, while the AC part of the left clavicle is pointing up (horizontal alignment). The left supraclavicular hole is more prominent and profound than the left one. The shoulder girdle sinister is located higher, compared to the right one. Both shoulders are in less protraction than in the initial examination. Both upper limbs are in the neutral position. Elbows are straight and not flexed. The head is in a straight position.

2.13.1.2 Lateral view (Right)

The Plumb line goes through 2cm frontally from malleolus lateralis, right beside the knee cap, in the back of the shoulder joint and slightly behind the earlobe, passing through the lateral part of the skull. Feet are slightly facing outwards. The ankle joint has no plantarflexion or dorsiflexion, and the feet are pointing outwards. The plumb line passes the contour of the shin. The shin line is symmetrical, not enlarged, and well-aligned. There is no visible hyperextension in the knee joint, and the left knee is not visible from the right side. Thigh muscles are well-aligned, with precise contour, without abnormalities. PSIS appears to be higher than SIAS, which signifies the pelvis misalignment. There is a visible hyperkyphosis at approximately the level of.

Th 3/4. The right arm is located alongside the body in a neutral alignment. The cervical spine is neutral, without forward protrusion or backward retrusion.

2.13.1.3 Lateral view (Left)

The plum line goes 2cm in front of the malleolus lateralis, right beside the knee cap, in the back of the shoulder joint, and slightly behind the earlobe, passing through the lateral part of the skull. The feet are in a slight outward position. The right leg is not visible from that point of view. PSIS appears to be higher than SIAS. There is visible kyphotisation of the thoracic spine in the third and fourth vertebrae region. The cervical spine is straight.

2.13.1.4 Posterior view

The Plumb line goes in the middle of the feet, vertebral column, subgluteal lines, and os occipital. Eversion of feet- Achilles tendons are straight, without being leaned to some angle. Feet are facing slightly outwards, signifying the whole LE minor external rotation. Popliteal lines are symmetrical on both knee joints; the slope goes from the lateral to the medial aspect of the knee, which is a precise contour of the thigh muscles with no significant difference. Subgluteal lines are located on the same level and have a symmetrical shape. Gluteal muscles

show some signs of hypotonus. Slight elbow flexion is visible from the posterior aspect. PSIS is located on the same level, with no signs of pelvic obliquity. Paravertebral muscles are symmetrical; the plumb line goes directly through the vertebral column, and there is no sign of lateral curvature of the spine. The position of the scapula on the left side is slightly higher than the right one. However, the size and shape of the scapula are proportionally equal. The right shoulder girdle is more depressed. Elbows are in a neutral position. The contour of the nuchal muscles is in a clear, well-aligned position. The head is not tilted straight; the line goes through the occipital bone.

2.13.2 Gait analysis

The patient has a rhythmic walk, equal load on both extremities, a slow gait pattern, and a slightly wider support base. Feet are adequately raised with proper knee flexion. The foot arch is appropriate during the gait. Gait has a physiological toe-off to the mid-swing phase. The first touch happened in the calcaneus's lateral part, and the takeoff phase finished in the big toe. No visible sign of hallux valgus. Feet are placed slightly outward during the complete foot contact. Normal extension of the hip during the terminal stance phase of gait. Symmetrical pelvic movement in anteversion, retroversion, and lateral tilt. Spinal junctions are on the same straight line during the walk—little sign of abdomen muscles involved in walking. Arm swing is proportional; however, it is minimal. The head is facing forward during the walk. Paravertebral muscles are proportionally active during the gait; the most mobile segment is the Th/L junction. Walking is done without losing balance or coordination.

2.13.3 Specific testing of posture

Romberg Test (I-III)

Romberg test I-negative

Romberg test II-negative

Romberg test III-negative

Single-leg stance test (open and closed eyes)- patient was able to stand on single leg with eyes closed, however failed to perform the same activity with the eyes closed

Trendelenburg sign- negative

Vele Test- grade one, good stability, no clawed or pressed toes.

Modification of standing:

Standing on tiptoes-was able to stand on tiptoes for about 5 seconds; fair ability to maintain balance.

Standing on heels- was not able to stand on the heels for 10 seconds.

2.13.4 Dynamic spine examination

Movement	Mobility
Flexion	Patient did not complain of any pain during the movement. The movement has not started from the head flexion, but rather in the lumbar spine. Thoracic spine was slightly more mobile in the segment of Th 3/7. Distance from the floor to the tip of the middle fingers was 5 cm. No signs of scoliosis
Extension	Patient did not have any pain during extension, however only minimal movement was observed. Patient's most mobile segment was between L4/S1
Lateroflexion (right)	Patient did not complain of any pain. Physiologic pelvic rotation was visible. Curvature is smooth and is slightly more visible in the segment of Th 3/7. Distance from the tip of the middle finger and the floor is 30 cm
Lateroflexion (left)	Patient did not complain of any pain. Physiologic pelvic rotation was visible. Curvature is smooth and is slightly more visible in the segment of Th 3/7. Distance from the tip of the middle finger and the floor is 28 cm

Table no 10: Final dynamic spine examination

2.13.5 Anthropometric measurements

Length of the Upper Extremity	Right	Left
Anatomical total length	85 cm	83 cm
Length of the humerus	38 cm	36 cm
Length of the forearm	47 cm	47 cm
Length of the hand	20 cm	20 cm

Circumferences of the Upper Extremity		
Circumference of the Upper Arm (relaxed)	35 cm	33 cm
Circumference of the Upper Arm (flexed)	38 cm	34.5 cm
Circumference of the elbow joint	29 cm	30 cm
Circumference of the forearm	29 cm	31 cm
Circumference of the wrist	18 cm	18 cm

Table no 11: Final anthropometric measurements (cm)

2.13.6 Examination of Range of Motion according to AMA (American Medical Association)

Shoulder joint				
Norms acc to AMA	Right		Left	
	AROM	PROM	AROM	PROM
S: 50-0-180	S: 50-0-180	S: 50-0-180	S: 35-0-90	S: 50-0-170
F: 180-0-0	F: 180-0-0	F: 180-0-0	F: 85-0-0	F: 170-0-0
R: 90-0-90	R: 80-0-80	R: 90-0-90	R: 40-0-60	R: 55-0-70
Elbow joint				
Norms	Right		Left	
	AROM	PROM	AROM	PROM
S: 0-0-140	S: 0-0-140	S: 0-0-140	S: 0-0-140	S: 0-0-140
R: 80-0-80	R: 80-0-80	R: 80-0-80	R: 80-0-80	R: 80-0-80

Wrist joint				
Norms	Right		Left	
	AROM	PROM	AROM	PROM
S: 60-0-60	S: 60-0-60	S: 60-0-60	S: 55-0-55	S: 60-0-60
F: 20-0-30	F: 15-0-25	F: 20-0-30	F: 15-0-25	F: 20-0-30

Table no 12: Final examination of AROM and PROM

2.13.7 Muscle length test (according to Janda or Kendall):

		Grade	
Length test	Author	Right	Left
Pectoralis major (lower sternal part)	Kendall	No Shortness	Shortness
Pectoralis major (upper clavicular part)	Kendall	No Shortness	Shortness
Pectoralis minor	Kendall	No Shortness	No Shortness
Teres major; latissimus dorsi; rhomboid major and minor	Kendall	Shortness	Shortness
External shoulder rotators	Kendall	Shortness	Shortness
Internal shoulder rotators	Kendall	No Shortness	No Shortness
Cranial part of trapezius	Janda	1	1
Levator scapulae	Janda	1	1
SCM	Janda	0	0

Table no 13: Final muscle length examination

2.13.8 Manual muscle strength test acc to Kendall

Movement	Muscles	Grade	
Cervical spine		Right	Left
Anterior neck flexion	longus capitis, longus colli, rectus capitis	4+	4+
Anterolateral neck flexion	SCM, scaleni	4+	4+
Posterolateral neck extension	splenius capitis and cervicis, semispinalis capitis and cervicis, cervical erector spinae	4+	4+
Shoulder			
Flexion	deltoideus, coracobrachialis	5	2+
Extension	deltoideus, latissimus dorsi, teres major	5	4-
Abduction	deltoideus, supraspinatus	5	2+
Extension in abduction	deltoideus	5	3-
Horizontal adduction	pectoralis major	4+	4+
Internal rotation	subscapularis, pectoralis major, latissimus dorsi, teres major	4+	3+
External rotation	infraspinatus, teres minor	4+	2+
Shoulder blade- Scapula			
Adduction	rhomboideus major et minor, trapezius (middle)	4+	3
Elevation	levator scapulae, trapezius (upper)	5	4+

Abduction with rotation	serratus anterior	4	4
Caudally	trapezius (lower)	4+	4+
Elbow			
Flexion	biceps brachii, brachialis, brachioradialis	5	4+
Extension	triceps brachii, anconeus	5	4+
Pronation	pronator teres, pronator quadratus	5	4
Supination	supinator, biceps brachii	5	4
Wrist			
Flexion with ulnar duction	flexor carpi ulnaris	5	5
Flexion with radial duction	flexor carpi radialis	5	5
Extension in ulnar duction	extensor carpi ulnaris	5	5
Extension in radial duction	extensor carpi radialis longus et. brevis	5	5

Table no 14: Final muscle strength examination

2.13.9 Active movement against resistance of rotator cuff muscles of the shoulder according to Cyriax

Movement	Right	Left
Against abduction	No pain	Pain
Against external rotation	No pain	Pain
Against internal rotation	No pain	No pain

Against supinated arm flexion (elbow flexed)	No pain	No pain

Table no 15: Final active movement against resistance examination

2.13.10 Basic movement pattern examination according to Janda

Shoulder abduction- right side without pathological findings, physiological abduction pattern. Patient was able to abduct left arm up to 80 degrees and the movement initially was observed in the upper trapezius and levator scapulae. After 80 degrees of abduction, the patient was performing lateral flexion to the right side and pain occurred.

Push up (from the wall) - scapula retracts and protracts in an optimal way. There is no visible scapula alatae during the movement.

Neck flexion- proper neck flexion without SCM taking over the movement. Chin was able to touch sternum and no pain was present

2.13.11 Functional movement limitations from ALD

Both hands on the head (flexion+abduction)- left hand was not able to reach the top of the head, only with the help of the right arm. Left hand could maximally reach the level of the mouth, without compensatory trunk extension

Both hands back from below (extension+internal rotation)- patient was able to bring both hands behind his back and was able to touch the region of L1

Hands behind head (hair brushing) - patient was not able to bring the left arm behind his head.

2.13.12 Joint play examination according to Lewit

Joint		Joint play	Result
	C2/C6	Rotation	Not restricted
		Side bending	Not restricted
		Shifting	Not restricted
	C/Th- Th3	Rotation	Not restricted
		Side bending	Not restricted

		Shifting	Not restricted
1st rib	Right	Neck flexion in lateral rotation	Not restricted
	Left	Neck flexion in lateral rotation	Not restricted
Scapula	Right	Prone	Not restricted
	Left	Prone	Restricted
AC joint	Right	Ventro-dorsal	Not restricted
		Craniocaudal	Not restricted
	Left	Ventro-dorsal	Not restricted
		Craniocaudal	Not restricted
SC joint	Right	Ventro-dorsal	Not restricted
	Left	Ventro-dorsal	Not restricted
GH joint	Right	Craniocaudal	Not restricted
		Ventro-dorsal	Not restricted
	Left	Craniocaudal	Restricted caudally
		Ventro-dorsal	Restricted ventrally
Elbow	Right	Radial	Not restricted
		Ulnar	Not restricted
	Left	Radial	Not restricted
		Ulnar	Not restricted
Wrist	Right	Dorsal	Not restricted

		Palmar	Not restricted
	Left	Dorsal	Not restricted
		Palmar	Not restricted

Table no 16: Final joint play examination

2.13.13 Soft tissue examination according to Lewit

Skin	Right	Left
Trapezius	Physiological	Physiological
Pectoralis	Physiological	Physiological
Ventral part of upper arm	Physiological	Decreased skin mobility, increased skin sensitivity and resistance especially in the area or scar
Dorsal part of the upper arm	Physiological	Decreased skin mobility
Ventral part of forearm	Physiological	Physiological
Dorsal part of forearm	Physiological	Physiological
Subcutaneous tissue		
Trapezius	Able to create a skin fold	Able to create a skin fold
Pectoralis	Able to create skin fold	Able to create skin fold
Ventral part of the upper arm	Physiological	Increased difficulty to create a skin fold, especially around scar
Dorsal part of the upper arm	Physiological	Physiological
Ventral part of the forearm	Physiological	Physiological

Dorsal part of the forearm	Physiological	Physiological
Fascia		
C/Th junction	Increased fascia resistance in rotation to the right and left	
Trapezius	Physiological	Physiological
Pectoralis	Physiological	Physiological
Ventral part of the upper arm	Physiological	Increased resistance in caudocranial and rotation directions
Dorsal part of the upper arm	Physiological	Physiological
Ventral part of the forearm	Physiological	Physiological
Dorsal part of the forearm	Physiological	Physiological
Muscles		
Paravertebral	Increased tonus	Increased tonus
Trapezius	Physiological	Physiological
Levator scapulae	Physiological	Physiological
Pectoralis major	Physiological	Physiological
Supraspinatus	Physiological	Decreased tonus
Infraspinatus	Physiological	Decreased tonus
Elbow flexors	Physiological	Decreased tonus
Elbow extensors	Physiological	Decreased tonus
Wrist extensors	Physiological	Physiological
Wrist flexors	Physiological	Physiological

Periosteal points		
C2 process	Physiological	
Rib-sternal junction	Physiological	Physiological
Ribs (horizontally)	Physiological	Physiological
Ribs (vertically)	Physiological	Physiological
AC joint	Slight increased sensitivity	Slight increased sensitivity
SC joint	Physiological	Physiological
Acromion	Physiological	Increased sensitivity
Processus coracoideus	Physiological	Increased sensitivity
Epicondylus medialis	Physiological	Physiological
Epicondylus lateralis	Physiological	Physiological

Table no 17: Final soft tissue examination

2.13.14 Neurologic examination according to Kolar

Sensory function

2.13.14.1 Superficial

Dermatomes (light stroke)- exact same feeling for right and left arm

2.13.14.2 Deep

Position sense is not disturbed on any of the extremities (patient was able to show direction of the movement and in which joint eh movement has occurred)

Stereognosis- Patient was able to describe the shape and size of all objects that he has been given to both hands (pencil, bottle, apple, hairbrush)

Graphesthesia- patient was able to identify all patterns, “written” on the skin on both UE

Tactile discrimination- As the distance between two “needles” was getting smaller(5<cm), the the patient could not identify between one or two “needles” being placed on his dorsal part of both arms. In ventral part of the arm it was identifiable for him

2.13.14.3 Deep Tendon reflexes (1- areflexia, 5-clonus/jerks)

UE	Right	Left
Biceps C5	3	3
Triceps C7	3	3
Radial C8	3	3
Finger jerk C8	3	3

Table no 18: Final DTR examination

2.13.15 Evaluation of the effect of the therapy

Upon the final kinesiology examination, some aspects of the patient's parameters have changed, and some have stayed the same. For example, regarding the static postural examination, there were no significant differences in anterior view compared to the initial examination, except for less shoulder protraction, and the left hand was not pronated. It is in a neutral position, and there was no flexion in the elbow joint. Both of the lateral views showed that there is less protrusion of the C spine, and the elbow joint is not flexed. Respecting the posterior view, there was no flexion in the elbow joints and no pronation in the left UE, unlike in the initial examination.

Regarding gait and specific posture testing, all tested parameters stayed the same. Dynamic spine examination showed no particular changes except a slight decrease in stiffness and an increase in overall curvature of the thoracic spine, particularly in forward flexion. Distance from the floor to the tip of the fingers is still the same - 5 cm and parameters of lateroflexion have not changed. However, most mobile segments are still Th/L. Regarding length parameters, the circumference of the left upper arm in the flexed state increased from 33 to 34.5 cm. Otherwise, the rest of the parameters are in its present condition**.** Regarding the examination of the range of motion, overall passive ROM increased while active ROM stayed relatively the same. The differences were seen in the shoulder joint in particular.

Shoulder joint (left)

PROM S: 50-0-170. 10 degrees increase in flexion

PROM F: 170-0-0. 10 degrees increase of abduction

AROM R: 40-0-60. 10 degrees increase in internal rotation

PROM R: 55-0-70. Five degrees increase in external rotation and 10 degrees increase in internal rotation.

According to Kendall and m., the muscle length test evaluation found no shortness in internal shoulder rotators (left). The levator scapulae and cranial part of the trapezius (left) are now moderately short with a slightly less brutal end feel.

After the examination of the muscle strength test, there was an improvement in the following movements:

1. The extension (deltoideus, latissimus dorsi, teres major) is now grade 4-, meaning the patient can hold the test position against slight to moderate pressure.
2. Internal rotation (subscapularis, pectoralis major, latissimus dorsi, teres major) in grade 3+ means the patient holds the test position against slight pressure.
3. Adduction (rhomboideus major et minor, trapezius middle) is now grade 3, meaning the patient holds a test position with no additional pressure applied.
4. Elevation (levator scapulae, trapezius upper) is now 4+, meaning the patient holds a test position against moderate to strong pressure.

The final examination results of the movement against resistance are identical to those of the initial examination. There were no changes to the pain character. Furthermore, the final examination of the basic pattern showed no difference in movement stereotypes from the initial one.

Regarding functional movement from the ADL, the patient does not experience any problems with fine motor skills, and he tries to use his affected extremities more in his everyday life. For example, he tries to brush his teeth or cut something while holding a knife in his left hand. However, I could not see the tasks mentioned above; the patient visibly uses his left hand more while dressing and undressing, opening and closing doors, and gesticulating. It is still challenging for the patient, as there was no significant increase in the active ROM or muscle strength. However, he feels more confident using his left hand and even more confident while driving.

Besides, there is an improvement in joint play; the following joints are not restricted anymore and have an excellent response to spinning test: C2/C6, C/Th-Th3, first rib (left), acromioclavicular and sternoclavicular joints (left) and elbow joint (left). However, joints remained blocked, the mobilisation, such as the glenohumeral joint (left) and scapula (left).

A final examination of the skin has shown the absence of increased sensitivity in the area of the trapezius (left) pectoralis (bilaterally), dorsal part of the upper arm and forearm (left), and ventral part of the forearm (left). Comparison of the subcutaneous tissue showed an

improvement in the trapezius bilaterally and dorsal part of the left forearm, where it became possible to create a physiological skin fold. Fascia examination showed an overall increase in the ability to move at the trapezius area bilaterally, the dorsal part of the left upper arm, and the whole forearm improved. Muscle tonus showed a shift from increased tonus to physiological in muscles: trapezius (bilaterally), pectoralis major (bilaterally), levator scapulae (left), wrist flexors, and extensors (left). However, There was no increase in tonus in those muscles initially found to be hypotonic, such as left supraspinatus, infraspinatus, elbow flexors, and extensors. A final examination of periosteal points has shown decreased sensitivity upon touch in many places, such as the rib-sternal junction, sibs themselves, sternoclavicular joint, and lateral and medial epicondyles on the left extremity. However, the acromion, processus coracoideus, and acromioclavicular joint were still sensitive upon palpation. A significant limitation in creating skin folds is the amount of fascia and subcutaneous tissue restricted as the ventral part of the upper arm, around the scar area, and the scar itself. Upon palpation, the scar was restricted to all directions and presented as it "got stuck" to the structures beneath it. This often causes pain directly at the scar to the patient as he moves with his left upper extremity.
Lastly, the final neurological examination showed no differences from the initial one.

2.13.16 Discussion

In my opinion, the patient really benefited from the STT. Muscle shortness decreased noticeably, due to the stretching of those muscles during the therapy and as part of self therapy. According to Iwata (2019), dynamic stretching can positively influence ROM, which can be also seen in the patient's case with the actual improvement in PROM. With the use of PIR technique we were able to decrease the hypertonicity of the muscle. The effectiveness of the method can be supported by the study done by Asad (2021). Muscle strength witnessed minor improvement, however studies have shown that exercises on cable machine and redcord positively influence muscle strength (40). Joint mobilisation took some time in terms of seeing positive outcomes and in my opinion as isolated technique is not very beneficial. It is best combined with other approaches such as active exercises and stretching (9). Even though the patient did experience a decrease in muscle tonicity and shortness, the area around the scar is still tight and has higher resistance. Studies claim that the scar mobilisation should be provided as soon as possible in order to avoid permanent morphological changes to soft tissue. In the case of my patient, the appropriate scar care was not introduced as soon as possible, hence it could have potentially influenced his condition. The scar which is already

“stuck” to a bone is challenging to mobilise and the only way to do it is to provide a recurring surgery to “loosen” it. In terms of ADL, the patient struggled with wheel turning the most and with the constant usage of his extremity he felt more confident. However it was happening to encourage the patient to use his affected UE, firstly because it's non-dominant and secondly for his daily life he only requires one hand (in majority of the cases). Since he is unemployed and did not mention any hobbies, it was hard to motivate the patient to use his non-dominant affected limb more in his day-to-day tasks.
Regarding the physical therapy modalities and my patient's diagnosis, if given an opportunity during my CWP, I would also apply laser therapy as a part of scar treatment. I think it would be beneficial in terms of tissue repair and regeneration to ease scar mobility and perhaps change the depth of attachment of the scar tissue to the deeper layers. I would use the laser modalities mentioned in section 1.4.2.3.1 in such a case.

2.13.17 Conclusion of the final kinesiological examination

A 55-year-old patient came for eight therapeutic sessions with chronic trauma of a fracture of the upper part of the humerus, which happened in May of 2022. From the beginning of the initial kinesiology examination and history taking, there were assumptions that there would not be a significant improvement to the patient's condition, especially considering the patient had many rehabilitation and physiotherapeutic sessions before. The patient spent 14 days in the rehabilitation department as an inpatient, then in December of 2022, he was hospitalised at Slapy Rehabilitation Centre for one month. After that, the patient regularly attended physiotherapy as an outpatient in Kladno Regional Hospital.
Overall, our goal was to focus on strengthening muscles responsible for abduction, flexion, and external rotation of the shoulder joint, hence increasing active ROM in the shoulder joint. The second most important focus was soft tissues, especially scars and muscles responsible for wrist extension, as they were overused due to the overcompensatory mechanism of shoulder movement. Even though the patient was motivated to exercise, he understood that after eight therapeutic sessions, he would not see much of an improvement since his condition is chronic. Despite our primary focus, the patient could not achieve significant improvements regarding muscle strength tests or active ROM in the shoulder joint. There was an improvement in overall usage of the left upper extremity as the patient engaged the left hand more in his ADLs and ended up feeling more confident while driving, regarding the fact that AROM has not increased. Even though we improved the conditions of some of the shortened and hypertonic muscles and worked with soft tissues, the scar has not seen significant

improvements in movement. It is attached to the deeper structure of the upper arm, which cannot be solved conservatively. Overall, there was a decent improvement in joint mobilisation as some joints were no longer blocked. Manual work with fascia, subcutaneous tissues, and muscles has also improved overall condition, making the patient experience less pain upon palpation.

Since the patient is almost entirely independent during ADL's activities, with his dominant limb being thoroughly unaffected, his condition does not require intense and immediate rehabilitation. However, it is essential to maintain a regime of constant exercises and manipulations to avoid worsening the condition and to see if slow progress will occur. The patient's main goal was to return to the initial state (before the trauma). Nevertheless, the patient recognizes his abilities and objective expectations from the physiotherapy.

The orthopedist who was operating on the patient told him that if the pain persisted and increased over time, he would advise him to do a total replacement of the shoulder joint, so before that, the patient wanted to try as many conservative treatments as possible to avoid surgical intervention.

My supervisor mentioned prior to the rehabilitation that the physiotherapy would be more about maintaining the patient's already achieved results rather than progressing in improving the condition. Nonetheless, I would like to thank my patient for participating in my bachelor thesis and wish him the best with his future rehabilitation journey, which will take place in Slapy Rehabilitation Centre in March 2024.

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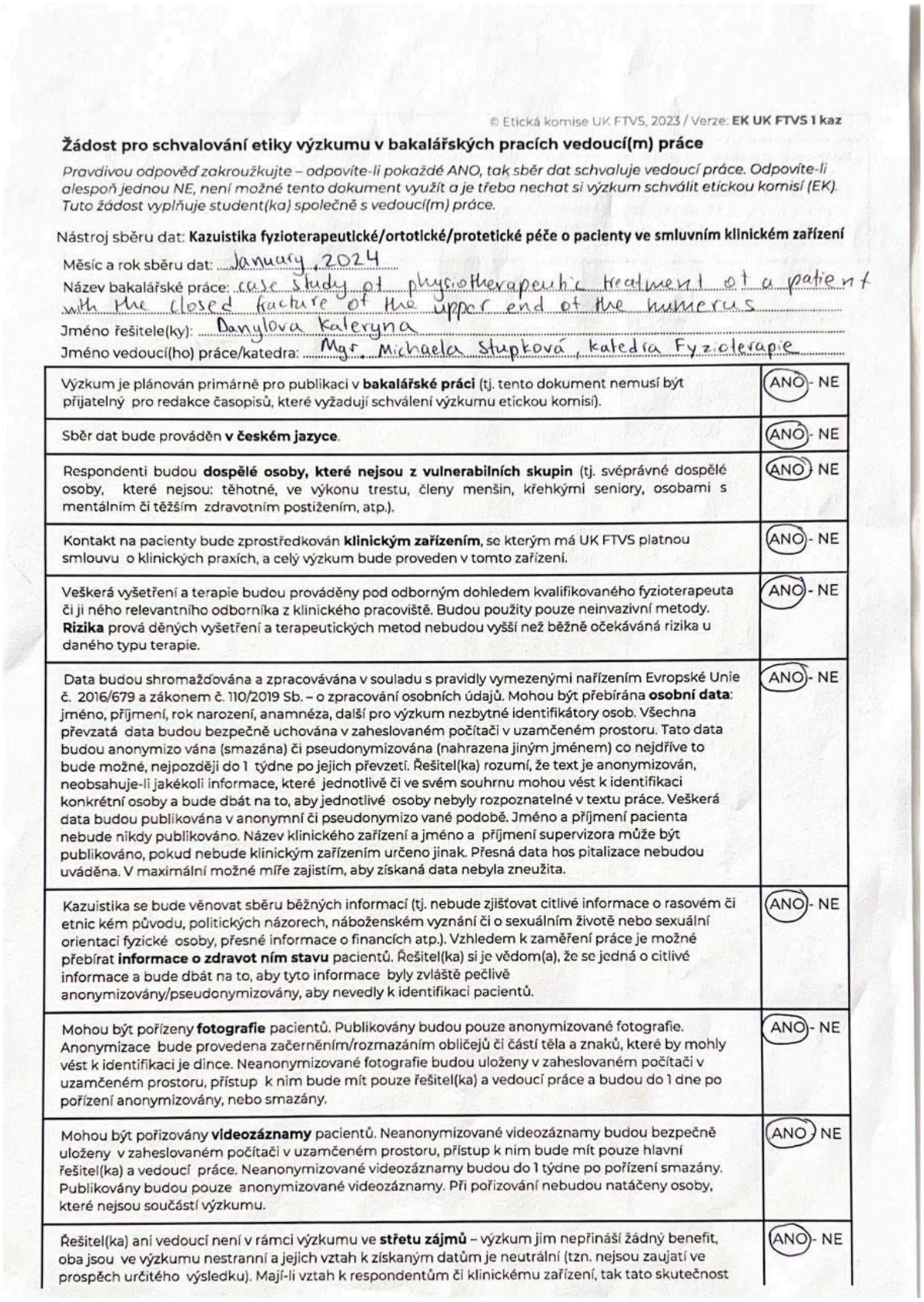
4 Supplement

4.1 List of Tables

4.2 List of Figures

4.4 Application for approval by UK FTVS Ethics Committee



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Žádost pro schvalování etiky výzkumu v bakalářských pracích vedoucí(m) práce

Pravdivou odpověď zakroužkujte – odpovíte-li pokaždé ANO, tak sběr dat schvaluje vedoucí práce. Odpovíte-li alespoň jednou NE, není možné tento dokument využít a je třeba nechat si výzkum schválit etickou komisí (EK). Tuto žádost vyplňuje student(ka) společně s vedoucí(m) práce.

Nástroj sběru dat: **Kazuistika fyzioterapeutické/ortotické/protetické péče o pacienty ve smluvním klinickém zařízení**

Měsíc a rok sběru dat: January, 2024

Název bakalářské práce: case study of physiotherapeutic treatment of a patient with the closed fracture of the upper end of the humerus

Jméno řešitele(ky): Danylova Kateryna

Jméno vedoucí(ho) práce/katedra: Mgr. Michaela Stupková, katedra Fyzioterapie

Výzkum je plánován primárně pro publikaci v **bakalářské práci** (tj. tento dokument nemusí být přijatelný pro redakce časopisů, které vyžadují schválení výzkumu etickou komisí).	(ANO) - NE
Sběr dat bude prováděn **v českém jazyce**.	(ANO) - NE
Respondenti budou **dospělé osoby, které nejsou z vulnerabilních skupin** (tj. svéprávné dospělé osoby, které nejsou: těhotné, ve výkonu trestu, členy menšin, křehkými seniory, osobami s mentálním či těžším zdravotním postižením, atp.).	(ANO) - NE
Kontakt na pacienty bude zprostředkován **klinickým zařízením**, se kterým má UK FTVS platnou smlouvu o klinických praxích, a celý výzkum bude proveden v tomto zařízení.	(ANO) - NE
Veškerá vyšetření a terapie budou prováděny pod odborným dohledem kvalifikovaného fyzioterapeuta či ji ného relevantního odborníka z klinického pracoviště. Budou použity pouze neinvazivní metody. **Rizika** prová děných vyšetření a terapeutických metod nebudou vyšší než běžně očekávaná rizika u daného typu terapie.	(ANO) - NE
Data budou shromažďována a zpracovávána v souladu s pravidly vymezenými nařízením Evropské Unie č. 2016/679 a zákonem č. 110/2019 Sb. – o zpracování osobních údajů. Mohou být přebírána **osobní data**: jméno, příjmení, rok narození, anamnéza, další pro výzkum nezbytné identifikátory osob. Všechna převzatá data budou bezpečně uchována v zaheslovaném počítači v uzamčeném prostoru. Tato data budou anonymizo vána (smazána) či pseudonymizována (nahrazena jiným jménem) co nejdříve to bude možné, nejpozději do 1 týdne po jejich převzetí. Řešitel(ka) rozumí, že text je anonymizován, neobsahuje-li jakékoli informace, které jednotlivě či ve svém souhrnu mohou vést k identifikaci konkrétní osoby a bude dbát na to, aby jednotlivé osoby nebyly rozpoznatelné v textu práce. Veškerá data budou publikována v anonymní či pseudonymizo vané podobě. Jméno a příjmení pacienta nebude nikdy publikováno. Název klinického zařízení a jméno a příjmení supervizora může být publikováno, pokud nebude klinickým zařízením určeno jinak. Přesná data hos pitalizace nebudou uváděna. V maximální možné míře zajistím, aby získaná data nebyla zneužita.	(ANO) - NE
Kazuistika se bude věnovat sběru běžných informací (tj. nebude zjišťovat citlivé informace o rasovém či etnic kém původu, politických názorech, náboženském vyznání či o sexuálním životě nebo sexuální orientaci fyzické osoby, přesné informace o financích atp.). Vzhledem k zaměření práce je možné přebírat **informace o zdravot ním stavu** pacientů. Řešitel(ka) si je vědom(a), že se jedná o citlivé informace a bude dbát na to, aby tyto informace byly zvláště pečlivě anonymizovány/pseudonymizovány, aby nevedly k identifikaci pacientů.	(ANO) - NE
Mohou být pořízeny **fotografie** pacientů. Publikovány budou pouze anonymizované fotografie. Anonymizace bude provedena začerněním/rozmazáním obličejů či částí těla a znaků, které by mohly vést k identifikaci je dince. Neanonymizované fotografie budou uloženy v zaheslovaném počítači v uzamčeném prostoru, přístup k nim bude mít pouze řešitel(ka) a vedoucí práce a budou do 1 dne po pořízení anonymizovány, nebo smazány.	(ANO) - NE
Mohou být pořizovány **videozáznamy** pacientů. Neanonymizované videozáznamy budou bezpečně uloženy v zaheslovaném počítači v uzamčeném prostoru, přístup k nim bude mít pouze hlavní řešitel(ka) a vedoucí práce. Neanonymizované videozáznamy budou do 1 týdne po pořízení smazány. Publikovány budou pouze anonymizované videozáznamy. Při pořizování nebudou natáčeny osoby, které nejsou součástí výzkumu.	(ANO) - NE
Řešitel(ka) ani vedoucí není v rámci výzkumu ve **střetu zájmů** – výzkum jim nepřináší žádný benefit, oba jsou ve výzkumu nestranní a jejich vztah k získaným datům je neutrální (tzn. nejsou zaujatí ve prospěch určitého výsledku). Mají-li vztah k respondentům či klinickému zařízení, tak tato skutečnost	(ANO) - NE

způsobem.	
Informovaný souhlas (IS) bude vytvořen podle Předlohy 1 a před použitím bude schválen vedoucí(m) práce před zahájením sběru dat. Obojí - **žádost** a **IS** - bude vyhotoveno ve 2 originálech: 1 x bude pode psaná žádost uschována u vedoucí(ho) práce v uzamčeném prostoru, spolu s podepsaným IS; a 1 x bude podepsaná žádosti spolu s odsouhlaseným textem IS (bez jmen, příjmení a podpisů, tj. pouze schválený text) přiložena jako Příloha 1 do bakalářské práce. 1 podepsaný IS obdrží pacient(ka).	(ANO) - NE

Podpis řešitele(ky): ..... Vyjádření vedoucí(ho) práce: 11 x ANO = není třeba podat žádost EK

Podpis vedoucí(ho) práce/katedry: .....

4.5 Informed consent

INFORMOVANÝ SOUHLAS

Vážená paní, vážený pane,

v souladu se Všeobecnou deklarací lidských práv, nařízením Evropské Unie č. 2016/679 a zákonem č. 110/2019 Sb. – o zpracování osobních údajů a dalšími obecně závaznými právními předpisy (jakož jsou zejména Helsinská deklarace, přijatá 18. Světovým zdravotnickým shromážděním v roce 1964 ve znění pozdějších změn (Fortaleza, Brazílie, 2013); Zákon o zdravotních službách a podmínkách jejich poskytování (zejména ustanovení § 28 odst. 1 zákona č. 372/2011 Sb.) a Úmluva o lidských právech a biomedicíně č. 96/2001, jsou-li aplikovatelné), Vás žádám o souhlas s prezentováním a uveřejněním výsledků vyšetření a průběhu terapie prováděné v rámci praxe ……..…. (uveďte, na kterém pracovišti), kde Vás příslušně kvalifikovaná osoba seznámila s Vaším vyšetřením a následnou terapií. Výsledky Vašeho vyšetření, průběh Vaší terapie, případně anonymizované relevantní informace Vaší anamnézy budou publikovány v rámci bakalářské práce na UK FTVS, s názvem …… (napište název práce)

Cílem této bakalářské práce je …….....

Získané údaje, průběh a výsledky terapie, případně fotodokumentace či video, budou uveřejněny v bakalářské práci v anonymizované či pseudonymizované podobě. Osobní data nebudou zveřejněna a budou uchována v anonymní podobě, nebo smazána nejdéle do 1 týdne po jejich převzetí. Budou-li pořízeny fotografie, budou anonymizovány do 1 dne po pořízení; bude-li pořízen videozáznam, bude anonymizován do 1 týdne po pořízení. V maximální možné míře zajistím, aby získaná data nebyla zneužita.

Jméno a příjmení řešitele .....
Podpis:.....

Jméno a příjmení osoby, která provedla poučení[1].....
Podpis:.....
Prohlašuji a svým níže uvedeným vlastnoručním podpisem potvrzuji, že dobrovolně souhlasím s prezentováním a uveřejněním výsledků vyšetření a průběhu terapie ve výše uvedené bakalářské práci, a že mi osoba, která provedla poučení, osobně vše podrobně vysvětlila, a že jsem měl(a) možnost si řádně a v dostatečném čase zvážit všechny relevantní informace, zeptat se na vše podstatné a že jsem dostal(a) jasné a srozumitelné odpovědi na své dotazy. Byl(a) jsem poučen(a) o právu odmítnout prezentování a uveřejnění výsledků vyšetření a průběhu terapie v bakalářské práci nebo svůj souhlas kdykoli odvolat bez represí, a to písemně zasláním Etické komisi UK FTVS, která bude následně informovat řešitele. Dále potvrzuji, že mi byl předán jeden originál vyhotovení tohoto informovaného souhlasu.

Místo, datum .....

Jméno a příjmení pacienta(ky) ..... Podpis pacienta(ky):
.....