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BACHELOR THESIS

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CHARLES UNIVERSITY
FACULTY OF PHYSICAL EDUCATION AND SPORTS
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Case Study of Physiotherapy Treatment of a Patient with the Diagnose of peripheral ankylosing spondylitis

Bachelor Thesis

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Declaration

The work proposed in my Bachelor's thesis, entitled **"Case Study of Physiotherapy Treatment of a Patient with the Diagnosis of Peripheral Ankylosing Spondylitis,"** was conducted under the supervision of Mgr. Ilona Kučerová, my supervisor, and my other professors in the physiotherapy department of the Faculty of Physical Education and Sport at Charles University.

In Prague: _____ _____

Author's signature

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In addition, I want to express my gratitude to my family for their unwavering support throughout my life and for providing me with the chance that I would not have otherwise had.

Abstract

Case study of physiotherapy treatment of a patient with a diagnosis of peripheral ankylosing spondylitis.

Work placement: Revmatologický ústav, Prague Na slupi 450/4, 128 00 Praha 2, Nové Město

Summary

This Bachelor Thesis is divided into two parts. The theoretical, and the practical part. The theoretical part mainly focuses on diseases such as their pathophysiology, signs & symptoms, and surgical & physiotherapy management. The practical part includes a case study consisting of a patient diagnosed with peripheral Ankylosing Spondylitis. It will focus on the treatments and examination approaches that have been taken for the patient, day to day therapies and the progression of the patient regarding the time he was in the hospital.

Keywords:

Ankylosing Spondylitis, Physiotherapy, Rehabilitation,

Abstraktní:

Případová studie fyzioterapeutické léčby pacienta s diagnózou periferní ankylozující spondylitida.

Pracoviště: Revmatologický ústav, Prague Na slupi 450/4, 128 00 Praha 2, Nové Město

Souhrn:

Tato bakalářská práce zahrnuje léčbu případové studie, u které byla diagnostikována periferní ankylozující spondylitida, a je rozdělena na dvě části, část teoretickou a praktickou.
Teoretická část je zaměřena především na nemoc jako takovou, jako je patofyziologie, anatomie, příznaky a symptomy, lékařský, chirurgický a fyzioterapeutický management a druhá část se zaměří na léčebné a vyšetřovací přístupy, které u pacienta zabraly, každodenní terapie a vývoj pacienta s ohledem na dobu, po kterou byl v nemocnici.

Klíčová slova:

Ankylozující spondylitida, Fyzioterapie, Rehabilitace,

1.Introduction

This Bachelor's Thesis research is based on a patient with Ankylosing Spondylitis. It will involve an overview of the disease, the pathophysiology principles, the clinical features and the symptoms of the disease, surgical and conservative ways of treatment, and finally, physiotherapy and rehabilitation after having the diagnosis. All these will be discussed in the thesis's general part (theoretical).

The special part (practical), which is the case study, will detail the patient's therapeutic interventions and the course of the therapy.

This thesis' major objective is to provide an overview of the topic of ankylosing spondylitis, including distinct kinds of the condition and available therapies, from both a theoretical and practical standpoint.

2 General Part

2.1 What is Ankylosing Spondylitis?

Ankylosing spondylitis (AS) is a systemic inflammatory rheumatic disease that affects the axial skeleton. It is commonly associated with the fusion of vertebral bones, and thus carries the potential to cause severe debilitation (Khan, 2003). AS is a considered as a severe subclass of axial spondyloarthritis. The main characteristics of AS include fibrosis and ossification of tendons and ligaments around intervertebral and sacroiliac discs causing said fusion (Hakim, & Clunie, 2002). Fibrosis is the thickening or scarring of tissue, whereas ossification is the process of laying down new bone material by cells named osteoblasts (this process is synonymous with osteogenesis or bone mineralization). The term axial spondyloarthritis only started being used in 2009 due to the development of the Assessment of Spondyloarthritis International Society Axial Spondyloarthritis (ASAS) classification criteria. For the first time, the ASAS criteria allowed earlier identification of axial spondyloarthritis through magnetic resonance imaging (MRI) (Casey et al., 2013).

Axial spondyloarthritis covers both non-radiographic and radiographic axial spondyloarthritis, which is also termed ankylosing spondylitis. As the name implies, non-radiographic axial spondyloarthritis does not show on x-rays, although MRI scans do reveal alterations. Males are affected with by ratio of 2:1 to females, with the condition typically starting after the age of thirty (Casey et al., 2013).

2.1.1 Anatomy of the Spine:

The body's primary support structure is the spine, also referred to simply as the backbone. It links various musculoskeletal structural components. The vertebrae support you when you sit, stand, walk, lean, and rotate (Cleveland Clinic, 2020). Three naturally occurring curves in a healthy spine form an S-shape. Your body is held in place by these curves, which also safeguard your spine from harm. Your spine is composed of several components:

33 stacked vertebrae, or fairly small bones, build up the spine, which forms the spinal canal. The spine is a tunnel that contains and safeguards the spinal cord and nerves from risk and danger. To enable a larger range of motion, the majority of vertebrae move. The sacrum and coccyx contain the lowest vertebrae, they are fused together and fixed, so they are not able to move (Bogduk N, 2016).

Facet joints: The cartilage (a fluid connective tissue) at these spinal joints enables the vertebrae to move in and out of contact with one another. Facet joints provide both elasticity and stability while allowing for twisting and rotating. These joints may undergo arthritis, which result in lowered range of motion (ROM) and neck/back pain (Cleveland Clinic, 2020).

The intervertebral disks function as the spine's suspension systems and thus are flat, spherical cushions that rest between the vertebrae. The nucleus pulposus, the soft, gel-like centre of each disk, is encircled by a malleable outer ring (the annulus). The pressure on the intervertebral disks is continuous. The gel substance that makes up the nucleus can spill out if a herniated disk ruptures. Disks that have herniated (also known as bulged, slid, or burst disks) might hurt (Bogduk N, 2016).

Spinal cord and the nerves: A section of nerves known as the spinal cord goes through the spinal canal. From the brain, which is protected by the skull, to the lower back, the cord continues. Through the gaps in the vertebra, 31 pairs of nerve grow out (the neural foramen). These nerves transmit signals from the brain to the muscles (DeSai et al., 2022).

Ligaments support the vertebrae in place by connecting them as soft tissues. The back is supported and moved by muscles. Tendons facilitate movement by joining muscles to bones (Cleveland Clinic, 2020). Five different spine segments are formed from the 33 vertebrae. These components, which begin at the neck and move toward your buttocks (back end), involve:

Cervical: There are seven vertebrae in the cervical (neck) region of the spine (C1 to C7). A lordotic curve is an inward C-shape formed by the cervical spine.

Thoracic: There are 12 vertebrae in the thoracic or chest region of the spine (T1 to T12). The thoracic spine is where the ribs connect. The kyphotic curve is the name given to the modest outward bend.

Lumbar: The lower section of the spine is made up of five vertebrae, from L1 to L5. The top regions of your spine are supported by your lumbar spine. It attaches to the pelvis and supports the majority of your body's weight as well as the strain from carrying and lifting heavy objects. Lumbar spine issues are a common cause of back issues. To form a lordotic curve in the shape of a C, the lumbar spine curves inward.

Sacrum: The hips are connected to this bone's triangle form. The five sacral vertebrae (S1 to S5) do not move because they fuse together as a baby grows inside the uterus. The pelvic girdle is a ring made up of the sacrum and hip bones.

Coccyx: This little bone fragment at the base of the spine is made up of four joined vertebrae. The coccyx is where ligaments and muscles of the pelvic floor attach (Cleveland Clinic, 2020).

2.1.2 Anatomy of Sacroiliac Joints:

The sacroiliac (SI) joint is a strong weight bearing compound joint, linking the pelvis and lower spine. It is made up of the sacrum and the top part of your pelvis (ilium). The SI joint consists of an anterior synovial joint (between the articular surfaces of the sacrum and ilium) and a posterior fibrous joint located between the tuberosities of said bones (Malinowski et al., 2021).

The SI joint has several distinctive characteristics often absent in other joints; including the presence of fibrocartilage, discontinuity of the posterior capsule, containing ridges and depressions in the articular surfaces, and having a limited range of motion (ROM) (Malinowski et al., 2021). Three main ligaments stabilize the SI joint: the thin anterior SI ligament, the thick interosseous ligament (which is critical for transmitting weight from the sacrum to the iliac bones), and the posterior SI ligament (Vleeming et al., 2012). The SI joint is richly innervated and contains free nerve fibres within the joint capsule and the adjoining ligaments, making it a sensitive region (Moore et al., 2014).

2.2 Pathophysiology

There is a great deal of uncertainty regarding the pathophysiology of ankylosing spondylitis. While there have been many advancements in this field, no definite cause has yet been identified. A number of factors such as genetics, the environment, as well as those related to immunity are thought to influence AS. With up to 90% of the risk of developing AS being believed to be genetics (Casey et al., 2013). Human leucocyte antigen (HLA) B27 and AS show the strongest association of all rheumatic diseases linked to genetic markers (Pham et al., 2008). HLA-B27 (Human Leukocyte antigen- B27) are proteins on the surface of leukocytes and other nucleated cells. These proteins enhance the human immune response in distinguishing between its own cells and foreign objects.

According to a research synthesis of linkage studies, the major histocompatibility complex (MHC) region on the short arm of chromosome 6 was the site of the strongest association (Carter et al., 2007). MHC is a cluster of genes located on chromosome 6 involved in antigen production. The interaction between HLA-B27 and T-cell responses have been cited as a key factor in the pathogenesis of ankylosing spondylitis (Sieper, 2009). Tumour necrosis factor (TNF)-α and interleukin 1 (IL-1) are understood to cause the inflammatory reactions observed in AS (Gorman 2002). TNF- α (Tumor Necrosis Factor- alpha) is a cytokine involved in systemic inflammation. It activates the immune system and thus induces inflammation to promote recovery. IL-1 (Interleukin 1) is critical in regulating immune responses. It also produces inflammation, and additionally promotes fever and sepsis. Research also demonstrates a possible link between AS and a specific bacterial agent called Klebsiella (which has an established relationship to HLA-B27). It is a bacteria that causes infections, and it is believed to initiate and maintain AS activity (Rashid, & Ebringer, 2007).

The occurrence of inflammatory reactions is a prominent feature of this illness. Enthesis fit into this category because they exhibit significant histological alterations. Destructive enthesopathy precedes healing in enthesis. New bone is formed as a result of healing; it is first laid down as cancellous

bone but eventually matures into lamellar bone. The production of bones creates the typical syndesmophytes (bony growths) that are seen on radiography of the spine with AS (Casey et al., 2013). Vertebral alterations are typically brought on by an erosive lesion at the anterior annulus fibrosis.

2.2.1 Enthesitis

An enthesis is a site on a bone where tendons, ligaments, fascia, or capsule attachment. It can lead to inflamed muscles with possible fibrosis and/or calcification. There are two types of entheses: fibrous and fibrocartilaginous. Enthesitis is the inflammation of one or more entheses. Enthesitis causes symptoms such as pain and stiffness in the affected ligament and joint capsule insertions, it generally leads to a decreased ROM. Inflammation may occur at any insertion point, however, enthesitis at the heel is reported to be the most common site (Dziedzic, & Hammond, 2010).

Enthesitis is considered to be a primary clinical feature of AS (Aydin et al., 2009). Studies propose that primary sites of immunopathology are the entheseal fibrocartilage and the cartilage at the interphase with bones (Sieper et al., 2002).

Below is an example of the enthesitis index (Maastricht AS Enthesitis Score (MASES):

This scale, which measures discomfort and irritation at these seven typical places during palpation, ranges from 0 (no sensitive spots) to 13 (mostly sensitive and irritated spots).

There are seven common sites for enthesitis in Ankylosing Spondylitis (Heuft-Dorenbosch et al., 2003):

1. Iliac crest (Right & Left)
2. PSIS (Right & Left)
3. L5 spinous process
4. Achilles tendon insertion (Right & Left)
5. 1st chostochondral junction (Right & Left)
6. 7th chostochondral junction (Right & Left)
7. ASIS (Right & Left)

Other enthesitis indices include: the Mander Enthesitis Index (MEI), Spondyloarthritis Research Consortium of Canada Enthesitis Index (SPARCC) and the Leeds Enthesitis Index (LEI) (Coates, & Helliwell, 2010).

2.2.2 Management of Enthesitis

Some doctors use physical examination to localize pain, stiffness, and inflammation, and then employ ultrasound or MRI in case it's necessary. Enthesitis can only be diagnosed with ultrasound

because a physical examination is insufficient (Balint et al., 2002). Regardless of how severe it is clinically, enthesitis has few treatment choices.

The mainstays of treatment are NSAIDs, local steroid injections (except from Achilles tendon due to high risk of tendon rupture), orthoses, and anti-TNF medications. Anti-TNF therapy that is monitored by ultrasound has been shown to be effective at easing enthesitis symptoms after two months (Aydin et al., 2009). As previously indicated, ultrasound is used to diagnose enthesitis because a physical examination is insufficient (Balint et al., 2002).

According to some research, the care of enthesitis affecting the plantar fascia and Achilles tendon may benefit by correcting foot biomechanics. This would entail adjusting the rearfoot's alignment and managing foot pronation to lower the possibility of the entheses getting more damaged. Although further study is required to back up this notion as there is still insufficient evidence supporting it (Dziedzic, & Hammond, 2010).

2.3 Pervasiveness

According to statistics, 1 in 200 people in Europe suffer from AS. (Braun, 2007). Whereas other assessments claim that between 0.25 - 1% of the world population (Calin, 2004) (Wordsworth, 2002). The male-to-female ratio ranges from 3:1 (Snaith, 2004) to 5:1 (McVeigh, & Cairns, 2006). There is a clear correlation between the prevalence of HLA-B27 and AS, where the higher the prevalence of HLA-B27, the higher the prevalence of AS. There are large differences between ethnic groups (David, & Lloyd, 1999):

	HLA-B27 positive	AS and HLA-B27 positive
Western Europeans	8 %	90 %
African Americans	2% to 4%	48 %

Table 1. Ethnic and racial variability in presence and expression of HLA-B27 (David and Lloyd 1999)

2.4 Common symptoms

Constantly shifting pelvic pain accompanying low back pain, stiffness, and soreness which is on the following page:

- more severe in the morning or at night
- enhanced through movement and/or activity
- lengthier than three months
    - contractions/spasms of muscles
    - Weakness/lethargy
    - Enthesitis

- Weight loss
- Low fever
- Uveitis

The symptoms of ankylosing spondylitis develop slowly over several months or even years. Symptoms can be episodic and change in severity over several years. AS usually begins to develop between the ages 20 to 30. Inflammatory pain in the spine is usually the first symptom of AS, resulting in decreased mobility of the spine and decreased chest expansion. Initial back pain is brief, but as the disease progresses, the pain persists. Women frequently exhibit AS in a distinct way than men experience, who tend to have a later age of onset, milder symptoms, more off-axis symptoms (Casey et al., 2013).

2.5 Clinical Features of AS

Skeletal	• Chronic low back pain and stiffness worsen by extended periods of inactivity (e.g., morning stiffness) • Alternating buttock pain • Night pain • Decreased lumbar mobility in all planes especially trunk lateral flexion and rotation • Abnormal posture: Increased thoracic kyphosis and decreased lumbar lordosis • Arthritis of 'girdle joints' (hips and shoulders) • Muscle Spasm • Enthesitis
Radiographic Features	Advanced stages: • Erosion • Sclerosis of adjacent bones • Widening of the sacroiliac joint, • Fibrosis, • Calcification, • Interosseous bridging, and ossification of the sacroiliac joints (Khan 2003).
Extra Skeletal	• Uveitis • Fatigue • Cardiovascular involvement Pulmonary involvement

Table 2. Clinical Features of AS (Khan 2002; Wolf 2012; Van der Linden 1998)

2.5.1 Involvement of Other Joints

Hip: About 30% of people with Ankylosing spondylitis have hip problems (Zochling., et al 2006). Higher total BASFI scores compared to AS patients without hip involvement highlight its association with reduced functioning, which is related to hip involvement (Vander Cruyssen., et al 2010).

The involvement of the hip contributes to the extent of the illness and its outcome, according to some prior research on the involvement of other joints.

Shoulder Involvement: Shoulder involvement is noted in 30% of ankylosing spondylitis cases. Although shoulder symptoms and loss of shoulder mobility are frequent in AS patients and are associated with greater pain levels, they are rarely incapacitating (Will et al., 2000).

Heel/Foot: According to a study called "MR imaging features of foot involvement in ankylosing spondylitis" (from the European journal of radiology), only 13% of AS patients had foot clinical signs and symptoms (such as pain and swelling) present. The main findings were bone erosions, Achilles tendinitis, joint effusion, plantar fasciitis, narrowing of joint space, edema of soft tissue, enthesopathy of the Achilles attachment, and bony ankylosis (Erdem., et al 2005).

2.6 Screening and Diagnosis of AS

Confirming a diagnosis of ankylosing spondylitis (AS) is difficult as the condition develops slowly and there is no definitive test. Early accurate diagnosis and intervention can significantly minimize or even prevent years of pain and disability (Casey et al., 2013). Nonetheless, since indications of AS are sometimes misdiagnosed for those of frequent diseases including persistent low back pain, diagnosis of AS is frequently prolonged. (Sieper, & Braun, 2011, Khan 2002). It's worth mentioning that research shows it often takes eight years to identify and detect AS. (Casey et al., 2013).

As with any other illness, diagnosing AS requires complete medical records, medical assessment, and evaluation of muscle tone, range of motion (ROM), flexibility, and joint play should be conducted to diagnose AS. Blood tests that assess erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) should also be performed to measure markers of inflammation in the blood. Furthermore, a genetic test can determine if you have the HLA-B27 gene. More than 90% of people with AS in Europe carry this gene (David, & Lloyd, 1999).

Three forms of radiological and clinical guidelines have been introduced over the preceding 40 years, with the reconfigured New York criteria (created in 1984) currently being the most frequently used to diagnose AS (Van der Linden, 1984; Van der Linden, 1996).

Since sacroiliitis is the best disease observational symptom, radiographic imaging is the main method used to identify AS. It is not a reliable method since typical pelvic radiographs might not detect sacroilitis in the early phase of AS. (Khan, 2002). After years of persistent inflammation, these radiographic irregularities frequently become apparent. (Sieper, & Braun, 2011).

Clinical criteria: • Low back pain; present for more than 3 months; improved by exercise but not relieved by rest. • Decreased lumbar spine mobility in both the sagittal and frontal planes. • Limitation of chest expansion.
Radiological criteria: • Sacroilitis visible in an X-ray.
Diagnosis: • Definite AS if the radiological criteria is present plus at least one clinical criteria. • Probable AS if a minimum of clinical criteria are present, or if the radiological criteria is present but no clinical criteria are present.

Table 3. Modified New York criteria (Van der Linden 1984)

2.6.1 Radiographic Findings

0	Normal
1	Suspicious changes
2	Minimal abnormality-small localized areas with erosion or sclerosis, without alteration in the joint width.
3	Unequivocal abnormality, moderate or advanced sacroilitis with one or more of: erosions, evidence of sclerosis, widening, narrowing, or partial ankylosis.
4	Severe abnormality-total ankylosis.

Table 4. Grading of radiographs (El Tecle et al., 2015)

2.7 Differential Diagnosis

2.7.1 Ankylosing Spondylitis vs Mechanical Low Back Pain

Ankylosing Spondylitis	Mechanical Low Back Pain
Early age of onset (under 45)	Older age (often older than 45)
Subtle onset	Often sudden onset
Morning stiffness > 30 minutes, stiff after sitting	Morning stiffness < 15 minutes, pain generally worse than stiffness
Eased with activity and worse at rest	Not better/worse after activity
Sacroiliac involvement causing alternating buttocks pain	Pain does not alternate
Often no clear positional/movement preference	Some movements tend to be more painful than others
75% show good or very good response to NSAIDs within 48 hours of treatment	15% of patients show good or very good response to NSAIDs within 48 hours of treatment

Table 5. Differential Diagnosis (Ankylosing Spondylitis vs Mechanical Low Back Pain) (Casey et al., 2013)

2.7.2 Distinguishing AS vs disc lesion (Sharp 1997)

The main difference between spinal injuries and AS in young individuals is that a disc rupture is often caused by a tragic event. Morning stiffness is generally not a problem in disc lesions. Furthermore, in disc lesions, symptoms get aggravated by activity rather than rest. In a disc prolapse, These are not characteristics of AS, but rather spinal branches with peripheral neuropathy, muscular weakness, and reflex alterations are highly prevalent.

2.8 Prognosis

After having the disease for at least 10 years, it is estimated that 75% of AS patients who have mild spinal mobility constraints won't become more severe spinal movement restrictions. In the first 10 years of the disease, patients with AS will often experience substantial spinal involvement, which can result in loss of movement and function. Hip inclusion worsens the condition's prognosis and contributes to its burden (Doran., et al 2003).

For those with AS, the prognosis is very good. The large majority of individuals can be effectively treated by managing their ailment medically and physically. Many patients do not need to alter their plans for their jobs and can continue to lead productive lives. Low morbidity and minimal, if any, lifetime reduction is associated with articular and extra-articular problems. (Barker., et al 2007).

2.9 AS Patients' Comorbid conditions & Difficulties

A swift diagnosis is essential because as the severity of the disease advances, the prospect of getting other complications also increases. Some of the comorbidities include in the following page:

1. Heart: engagement of the aorta, poor conduction, hypertension,
2. Bone: Osteoporosis
3. Lungs: Apical Fibrosis, Chest wall restriction & Pulmonary restrictions
4. Cachexia
5. Gastrointestinal tract (GIT)
6. Skin

2.9.1 Heart Problems

Cardiac pathologies are a well-documented area of complications associated with AS, it affects between 10 - 30% of AS patient (Roldan et al., 2008). Seemingly, the lower the patient's age, the higher the risk of contracting a heart complication. Often, cardiac problems in AS goes undiagnosed until the patient is symptomatic. The most common complications include bradycardia or aortic incompetence (Kazmierczak et al., 2008). AS patients have twice the increased death rate compared to the general population, this is primarily due to said increased cardiovascular risk (Lautermann, & Braun, 2002).

2.9.1.1 Aorta Involvement

AS patient valves are described to get fibrotic, thickened, and retracted points with rolled edges. This commonly advances into aortic insufficiency. Aortic valve disease has been reported in 4% of early AS (affected by disease less than 15 years) and 10% in later stages of the disease (affected by disease more than 30 years) (Lautermann, & Braun, 2002).

2.9.1.2 Conduction Abnormalities

There are two prevalent theories regarding the aetiology of conduction abnormalities in AS. The first theory states that there may be inflammation in the intraventricular septum which leads to damage. The second theory states anomalies in the AV nodal artery lead to AV node dysfunction (Momeni, 2001). It is possible that both theories may act in part.

2.9.1.3 Hypertension

The chance of obtaining hypertension is increased in AS patients by 8 - 18% when compared to the general population. European Alliance of Associations for Rheumatology (EULAR) recommends that hypertension should be managed the same way as any other patient. Exercise programs can

reduce blood pressure as they can correct physiological changes associated with hypertension (Peters et al., 2009).

2.9.1.4 Smoking

A study with 612 AS patients was carried out to determine the relationship between smoking and disease activity, pain, function, and quality of life in AS patients (Mattey et al., 2011). It determined that smoking had a dose-dependent relationship with AS severity. AS patients that smoke exhibited reduced lung volumes and exercise tolerance which in turn exacerbated spinal mobility when compared to non-smokers (Kaan, & Ferda, 2005).

2.9.2 Bone Problems

2.9.2.1 Osteoporosis

A common aspect of AS is generalized osteoporosis. In the initial stages of the illness, bone loss occurs frequently and mostly affects the spine. Studies have shown that a significant portion of AS patients, are either osteopenic (59%) or osteoporotic (18%), which can affect up to and of AS patients, correspondingly (El Maghraoui, 2005). In the initial phases of the illness, osteopenia and/ or osteoporosis were visible in one-third of the patients, and as individuals get older and the condition lasts longer, deteriorating bone loss becomes apparent (El Maghraoui et al.,1999).

Furthermore, investigations throughout time have shown that persistent inflammation, one of the main symptoms of AS, that is uncontrolled by medicine, is a significant determinant of bone density reduction (Maillefert et al., 2001).

Generally, however, it is unclear what causes osteoporosis associated to AS. It is hypothesized that a number of causes, such as lingering inflammation, hereditary factors, drug side effects, and a gradual loss of spinal motion due to advancing ankylosis, contribute to bone loss.

Osteoporosis is hypothesized to occur in AS patients for a variety of reasons, including low body weight and BMI, longer AS disease duration, decreased functional capacity, increased disease activity, and decreased activity levels (Ghozlani et al., 2009).

2.9.3 Lung Problems

Pulmonary complications have also been well documented in AS patients (El Maghraoui, 2005). The pathophysiology related to pulmonary complications in AS is unclear, however, the most prominent belief is a disease specific inflammatory process (El Maghraoui, 2011). Complications include fibrosis of the upper lobes, sleep apnoea, spontaneous pneumothorax, interstitial lung disease and ventilatory impairment (due to chest wall restriction). High-resolution computed tomography (HRCT) assisted in demonstrating 70% of AS patients had respiratory restrictions.

2.9.4 Cachexia

This is described as "a rapid loss of skeletal muscle in the midst of a prolonged inflammatory response." (Kotler, 2000). Muscle atrophy is a straight consequence of this catabolic mechanism.

frailty, physical impairment, a higher risk of infection, and early mortality. It is thought that cachexia in AS patients is triggered by elevated body levels of tumour necrosis factor (TNF) and other pro-inflammatory cytokines (Kotler, 2000).

A study called “Preliminary evidence for cachexia in patients with well-established ankylosing spondylitis” examined the withering of muscle in AS patients. The average duration of AS in 19 patients was compared to 19 age-matched controls who engaged in comparable levels of physical activity. To measure body composition, dual energy X-ray absorptiometry was employed.

Isokinetic knee extension, hand grip dynamometry, 30-second arm curl, and chair sit-to-stand tests were used to measure muscle strength. Results showed that patients with AS had a clinically and statistically significant 12% loss of skeletal muscle mass in their arms, legs, and entire body compared to healthy controls. Lower and upper body strength was substantially correlated with this muscle loss. Therefore, it is clear that cachexia, especially in those with severe disease, is a functionally meaningful systemic consequence of AS (Marcora et al., 2006).

Furthermore, research on body composition, like the one discussed previously, have not consistently shown that AS patients had decreased muscle mass.

2.9.5 Gastrointestinal tract (GIT) Problems

Between 5 - 10% of AS patients have been reported to be sick with Crohn’s disease, ulcerative colitis, or gut inflammation (De Keyser, & Mielants, 2003). This inflammation of the gut is strongly connected to the course AS as investigations exhibit that remission of joint inflammation is commonly associated with subsequent remission of gut inflammation (Maghraoui, 2011).

2.9.6 Skin Problems

Between 10% and 25% of AS patients get psoriasis lesions (Maghraoui, 2011). Furthermore, patients with psoriasis are generally have a worse prognosis compared to both primary AS and AS patients with inflammatory bowel disease (Lavie et al., 2009).

2.10 Outcome Measures for Assessment of AS

2.10.1 Bath Ankylosing Spondylitis Functional Index (BASFI)

BASFI is a collection of ten questions intended to determine the degree of functional limitation in AS patients. It is measured using a scale ranging from 0 (easy) to 10 (impossible). The questions are focused on the patient’s ability to perform specific functional tasks. The first eight questions reflect

activities related to functional anatomy (with an example of putting on socks with/without help of steps or handrails). The last two questions focus the patient's ability to manage with everyday life. The BASFI is considered to be valid and reliable (Ruof, & Stucki, 1999).

The BASFI items and scoring (Calin et al., 1994): the table below exhibits the questions asked to the patient in order to indicate the level of their functional ability in the activities from the past week.

1) Putting on your socks or tights without help or aids (e.g sock aid).	1 2 3 4 5 6 7 8 9 10
2) Bending from the waist to pick up a pen from the floor without aid.	1 2 3 4 5 6 7 8 9 10
3) Reaching up to a high shelf without help or aids (e.g helping hand).	1 2 3 4 5 6 7 8 9 10
4) Getting up from an arm less chair without your hands or any other help.	1 2 3 4 5 6 7 8 9 10
5) Getting up off the floor without help from lying on your back.	1 2 3 4 5 6 7 8 9 10
6) Standing unsupported for 10 minutes without discomfort.	1 2 3 4 5 6 7 8 9 10
7) Climbing 12-15 steps without using a handrail or walking aid.	1 2 3 4 5 6 7 8 9 10
8) Looking over your shoulder without turning your body.	1 2 3 4 5 6 7 8 9 10
9) Doing physically demanding activities (e.g physiotherapy exercises, gardening or sports).	1 2 3 4 5 6 7 8 9 10
10) Doing a full days activities whether it be at home or at work.	1 2 3 4 5 6 7 8 9 10

Table 6. The BASFI Items and Scoring (Calin et al 1994)

2.10.2 Bath AS Disease Activity Index (BASDAI)

BASDAI is standard for measuring AS progression and the functional status of the person affected. Similar to the BASFI, the BASDAI consists of a one (none) to ten scale (very severe). However, in this index there are six questions instead of ten. The questions focus on the key symptoms of AS.

Bath AS Disease Activity Index (BASDAI) questionnaire

How would you describe the overall level of fatigue/tiredness you have experienced?	None_____very severe
How would you describe the overall level of AS neck, back or hip pain you have had?	None_____very severe
How would you describe the overall level of pain/swelling in joints other than neck, back, hips you have had?	None_____very severe
How would you describe the overall level of discomfort you have had from any areas tender to touch or pressure?	None_____very severe
How would you describe the overall level of morning stiffness you have had from the time you wake up?	None_____very severe
How long does your morning stiffness last from the time you wake up?	0 hrs, 1/2, 1, 1 1/2, 2 or more hours

Table 7. The Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) questionnaire samples : (Garret et al 1994)

2.11 Medical Management of AS

2.11.1 Non-Steroidal Anti-Inflammatory Drugs (NSAIDs)

- Traditional NSAIDs: Ibuprofen, Diclofenac, Naproxen, Indomethacin
- COX-2 Inhibitors: Celecoxib, Etoricoxib

Mechanism of Action:

NSAIDs block the COX enzymes and reduce prostaglandins (lipids made at sites of tissue damage) throughout the body, thereby reducing inflammation.

Uses of NSAIDs in AS (Zochling et al., 2006):

- Reduction of spinal and peripheral joint pain
- Increase in function over a short period of time (6 weeks)
- Reduction of enthesitis

Side-effects of NSAIDs (Casey et al., 2013):

- Increased risk of GI bleeding
- Nausea
- Vomiting
- Diarrhoea

- Constipation
- Decreased appetite
- Rash
- Dizziness

Serious (rare) side-effects:

- Kidney failure
- Liver failure
- Ulcers
- Prolonged bleeding following injury or surgery

Recommendations for NSAIDs in AS management (Braun et al., 2010):

- First line drug treatment for AS patients with pain and stiffness
- Continuous NSAIDs treatment is recommended for patients with continual symptoms.
- Before starting NSAIDs, it is crucial to check for cardiovascular, GI and renal risks.

2.11.2 Analgesics (Garry et al., 2005)

Analgesics are medications prescribed to relieve pain. Common analgesics prescribed for AS patients include paracetamol opioids.

Mechanism of Action:

Paracetamol: it is a weak inhibitor of prostaglandin (PG) synthesis. The analgesic effect of paracetamol is central and due to activation of descending serotonergic pathways. However, the primary mode of activation is the inhibition of PG synthesis.

Opioids: it inhibits of the release of glutamate (the most abundant excitatory neurotransmitter) from peripheral nociceptors and postsynaptic neurons in the dorsal horn. This reduces the intensity of pain signals reaching the brain, thus lowering the effects of painful stimuli.

2.11.3 Corticosteroids

Corticosteroids can be taken orally or be injected; they are steroid hormones prescribed to decrease inflammation. Some of the side effects of systemic corticosteroids comprise of lower extremity swelling, hypertension, headaches, easy bruising, growth of facial hair, diabetes, and more.

Mechanism of Action:

Corticosteroids combine with steroid receptors in the cytoplasm of cells. The formation of a inhibitory protein to the enzyme phospholipase A2 occurs. Phospholipase A2 enzyme is responsible for the supply of arachidonic acid which produces of inflammatory mediators. Therefore, by inhibiting this process, corticosteroids reduce inflammation.

Arachidonic acid is a polyunsaturated fatty acid present in phospholipids of cell membranes. It is primarily found in brain, muscle and liver cells (National Centre for Biotechnology Information).

Purpose of usage:

Targeting local inflammation:

- Axial joints
- Peripheral joints
- Enthesitis

Side-Effects:

- Elevated pressure in the eyes (Glaucoma)
- Cataracts
- Fluid retention leading to oedema
- Increased blood pressure
- Altered blood sugar levels which can trigger or worsen diabetes
- Weight gain
- Increased risk of infection
- Suppressed adrenal gland hormone production
- Delayed wound healing

2.12 Surgical Management of AS

2.12.1 Total Hip Arthroplasty (THA)

Patients who have residual symptoms or dysfunction and imaging indications of structural deterioration should be related to having total hip arthroplasty.

Common side effects	Rare side effects
Sedation	Delayed gastric emptying
Dizziness	Hyperalgesia
Nausea	Muscle rigidity
Vomiting	Myoclonus
Constipation	
Physical dependence	
Tolerance	
Respiratory depression	

Table 8. Side-Effects of Analgesics (Benyamin et al 2008)

Patients who have residual symptoms or dysfunction and imaging indications of structural deterioration should be related to having total hip arthroplasty. Regardless of age, THA is a great treatment option for AS patients with severe hip involvement symptoms (Braun et al., 2005).

The operation's outcome will illustrate:

- Enhanced performance and discomfort (Bhan et al., 2008)
- Following THA, 65% of patients had excellent hip function and 96% experienced great pain reduction.
- After 27 years, there has been a 71% survival rate for prostheses (Joshi et al., 2002).
- Clearly noticeable reductions in pain, function, and ROM (Brinker et al., 1996).

2.12.2 Spinal Corrective Surgery

Chronic discomfort, skeletal deformity, and fracture are all effects of AS. Through a long-term inflammatory process that results in a minimally compliant spinal column, the disease process changes the biomechanics of the spine.

When the annulus fibrosis of the intervertebral disc inserts into the vertebral body, inflammation results in erosion of the vertebral body. Therefore, the vertebrae become square and have "shiny corners" as a result of this process (Romanov lesions). The result is that AS patients are likely to suffer from unstable spinal fractures and neurological impairments even in the case of minor damage (Westerveld et al., 2008).

Spinal Fractures:

Compared to the general population, AS population is four times more likely. Individuals with AS are more vulnerable to falling because they are:

- Altered gait
- Impaired balance
- Extended illness duration
- Abuse of alcohol
- Falls and progressive kyphosis increase the risk of spinal fractures.

Cervical Fractures:

The most common places for spinal fractures in AS are the sub axial cervical spine. extremely unstable, with an elevated risk of neurological deficiency and a death rate that is double that of the average population (Casey et al. 2013).

Thoracolumbar Fractures:

Much less typical than cervical. Several take place at the thoracolumbar junction, including:

- Deforming damage
- Compression of a wedge
- Pseudoarthrosis due to persistent malunion

There is no universal agreement on the best way to treat spinal fractures in people with AS. Although immobilization as part of conservative therapy may be sufficient, many patients find this approach intolerable (Casey et al., 2013).

Surgical procedures:

- Decompressive laminectomy
- Opening-wedge osteotomy
- Polysegmental wedge osteotomy with internal fixation (Braun et al., 2005).
- Monosegmental intravertebral closing-wedge posterior osteotomy of the lumbar spine (Casey et al., 2013).

Evidence Base Surgical Characteristics:

Vertebral fractures treated surgically in ankylosing spondylitis patients (Sapkas et al., 2009).

20 AS patients are having spinal fracture surgery (7 cervical, 9 thoracic, 3 thoracolumbar junction, 1 lumbar) There were none throughout the operation. The neurological status of the patients was assessed using the Frankel neurological classification.

According to the Frankel classification, surgery improved the patient's neurological condition where it was compromised. The surgical procedure appears to be effective and beneficial (Casey et al., 2013). Acute spinal cord injury is categorized according to the Frankel Neurological Classification evaluating system:

Grade A: total neurological damage; there is no evidence of motor or sensory innervation below the degree of the damage.

Grade B: only preserved sensation; clinically, there is no evidence of motor function below the level of the damage. While still below the level of the injury, sensory function may only be partially functional.

Grade C: despite the fact that the motor function is still present, it is inoperative.

Grade D: kept meaningful motor function below the injury's level. Although the patient is capable of moving their lower limbs and walking with or without assistance, they have a compromised gait pattern.

Grade E: neither defective motor nor sensory function has been clinically identified. There will be regular sphincter activity. There could be irregular reflexes as well as subjective sensory abnormalities (Waikar et al., 2007).

2.13 The Multidisciplinary Team (MDT)

The rheumatology multidisciplinary team deals with investigating, diagnosing, managing, and treating patients with AS, arthritis, and other musculoskeletal conditions. It is crucial to have a multidisciplinary team as they can all assist in reducing symptoms and improving quality of life with different methods. This includes taking medications, practicing gross motor skills, and improving fine motor skills.

Core members of the Multidisciplinary Team
Patient and Carer
Rheumatologist
Physiotherapist
Occcupational Therapist
Nursing Staff/Rheumatology Nurse Specialist

Table 9. Core members of the Multidisciplinary Team

Rheumatologists are doctors that specialize in diagnosing and treating arthritis, osteoarthritis, and other musculoskeletal problems. They decide the initial treatment and oversee the long-term management of the condition (NASS, 2010). Rheumatologists conduct many practical procedures such as joint aspiration, joint injection, ultrasound, arthroscopies, muscle biopsies and more. Most diseases rheumatologists treat are chronic and often incurable diseases.

This makes a collaborative treatment approach more effective. Efficient communication and cooperation amongst the members of the MDT is vital (Dziedzic, & Hammond, 2010). Recent studies have revealed that a combination of biological treatment, physical therapy, and occupational therapy produce positive effects such as reducing pain, improving function, and improving health-related quality of life (Dubey et al., 2008). Teams may grow or shrink in size depending on who is required at different stages of the disease cycle. Different specialist skills are required at different times. However, it is important to remember that the patient is the most important member of the team (David, & Lloyd, 1999). Depending on the severity of the disease, patients may meet their rheumatologist frequently for treatment, or once a year for monitoring. (Lubrano et al., 2006).

2.13.1 Role of the Occupational Therapist:

The occupational therapist's goal is to maintain and if possible, improve patient's fine motor skills, their ability to perform daily tasks, adapt to disturbances in lifestyle, and prevent loss of function.

2.13.2 Physiotherapy management in Ankylosing Spondylitis:

- Physiotherapists play a crucial role in the management of AS, the goal of physiotherapy is (Ozcogmen et al., 2012):
- Reducing pain and discomfort
- Maintaining and improving muscle strength
- Maintaining and improving muscle endurance
- Maintaining and improving ROM
- Maintaining and improving physical function
- Improving overall quality of life
- Preventing spinal curve abnormalities and joint deformities

The importance of physiotherapy is even clearly stated in the updated EULAR recommendations for managing Ankylosing Spondylitis (Braun et al., 2011). Physiotherapy in patients with AS involves patient education and regular exercise AS (Zochling et al., 2006).

Component of the exercise:

- Posture:

Postural education is significant: the physiotherapist gives the patient an understanding of good posture with a neutral spine. As the disease progresses, the spine tends to lose its natura curves, so holding good posture is essential to reduce said affects. This understanding is provided through a verbal explanation and/or practical demonstration and using tools for feedback (ex: visual feedback aids such as mirrors). This also improves the patient's proprioception.

- Aerobic Exercise:

As previously mentioned, patients who have AS tend to get pulmonary complications and restricted breathing (Carter et al., 1999). This directly reduces exercise tollerence, which is why cardiopulmonary exercises are excellent for AS patients. This improves the vital capacity (Ozdem et al., 2011), physical fitness, and endurance (Ozgocmen et al., 2012). An added bonus of these exercises is that they also reduce risk of cardiovascular diseases (Halvorsen et al. 2012).

- Strengthening Exercise:

Strengthening exercises are recommended to maintain where possible, improve muscular strength in AS patients (Halvorsen et al., 2012)

- Flexibility Exercise:

Stiffness and reduced mobility are characteristic symptoms of AS. Active and passive stretching helps maintain flexibility of muscles, and other soft tissues and thereby maintain ROM (Zochling, 2006).

- Spa Therapy:

    Climatotherapy

    Hydrotherapy

    Balneotherapy

2.14 Evaluation of Evidence Based Medicine

2.14.1 Case study 1 (Eppeland et al., 2013)

The first case study is called "Short term in-patient rehabilitation in axial spondyloarthritis - the results of a 2-week program performed in daily clinical practice". It was written by Siv Grødal Eppeland, Andreas P Diamantopoulos, Dag Magnar Soldal and Glenn Haugeberg. The purpose of this case study was to "The aim of this study was to evaluate the effect of a 2-weeks rehabilitation program on self-reported outcome and physical function in patients with axial spondyloarthritis (ax-SpA) including AS patients carried out in ordinary clinical practice. The program contained of daily water exercises, exercises for flexibility, muscle strength, and cardio-respiratory fitness". 87 ax-SpA patients (60 men, 27 women), aged ≥ 18 years participated in the 2-weeks in-patient rehabilitation program. The mean age was 49 years and disease duration were 14 years. The results showed that patients reported outcomes showed a statistically significant improvement after two weeks; the Bath Ankylosing Spondylitis (BAS) Disease Activity Index had previously been 4.3; after two weeks, it had changed to 3.1, indicating a quick improvement. While the standing measurement duration fell somewhat from 22.5 to 16,3 s, the gait velocity increased slightly from 2,2 to 2,6 m/s. But overall, there has been a tremendous improvement in physical fitness. The conclusion of the study was that the data supported that patients with ax-SpA benefit from a short-term rehabilitation programme even when it is carried out of a traditional clinical care facility.

2.14.2 Case study 2 (Gravaldi et al., 2022)

The second case study is called "Effectiveness of Physiotherapy in Patients with Ankylosing Spondylitis: A Systematic Review and Meta-Analysis". It was written by Luca Pontone Gravaldi, Francesca Bonetti,* Simona Lezzerini, and Fernando De Maio. The aim of the study was to "This study aimed to evaluate the safety and effectiveness of non-pharmacological interventions supervised by a physiotherapist in patients with Ankylosing Spondylitis, PROSPERO Protocol

number CRD42020209453. Five databases (PubMed, PEDro, Scopus, Web of Science Core, and EMBASE) and reference lists with relevant articles were searched. Randomised controlled trials (RCTs) on the effectiveness of non-pharmacological interventions supervised by a physiotherapist were compared with usual care or home-based exercise programmes. A total of 12 RCTs satisfied eligible criteria." The results showed that "The meta-analysis results indicated that between supervised physiotherapy and usual care, the former was significantly associated with improvement in disease activity (standardised mean difference = −0.37, 95% CI, −0.64; −0.11; $p < 0.001$, $I2 = 71.25\%$, n = 629), and functional capacity (standardised mean difference = −0.36, 95% CI, −0.61; −0.12, $p < 0.05$; n = 629)." The study concluded that "Supervised physiotherapy is more effective than usual care in improving disease activity, functional capacity, and pain in patients with ankylosing spondylitis. No significant improvements emerged when supervised physiotherapy and home-based exercise programmes were compared."

2.14.3 Case study 3 (Pécourneau et al., 2018)

The third case study is called "Effectiveness of Exercise Programs in Ankylosing Spondylitis: A Meta-Analysis of Randomized Controlled Trials". It was written by Virginie Pécourneau, Yannick Degboé, Thomas Barnetche, Alain Cantagrel, Arnaud Constantin, and Adeline Ruyssen-Witrand. The aim of this study was to "assess the effectiveness of exercise programs on disease activity and function in ankylosing spondylitis (AS) by a systematic review and meta-analysis of randomized controlled trials (RCTs)". The results of the study stated that "after screening 190 abstracts, we selected 26 reports for detailed evaluation and finally investigated 8 trials that assessed a home-based exercise program (2/8), swimming (1/8), Pilates training (1/8), or supervised exercises (4/8), for a total of 331 patients with AS. Four trials included patients receiving antitumor necrosis factor therapy. All trials except one showed a decrease in BASDAI and BASFI with exercise. The weighted mean difference was -0.90 (95% confidence interval, -1.52 to -0.27; I2=69%; P=.005) for the BASDAI and -0.72 (95% confidence interval, -1.03 to -0.40; I2=0%; P<.00001) for the BASFI in favour of exercise programs". The conclusion of the study was that "despite the small number of patients and the heterogeneity of exercise programs in the RCTs included in this meta-analysis, its results support the potential of exercise programs to improve disease activity and body function in AS."

3. Special Part

3.1 Methodology

The special part (Practical part) of this bachelor thesis is based on my clinical work placement practice, which took place at the physiotherapy department of Revmatologický ústav in Prague, which took place from 10/01/2022 – 04/02/2022 under the supervision of Bc. Petr Velisek. The Revmatologický ústav is a medical facility, institute, and hospital specializing in rheumatologic diseases, so patients afflicted by such illnesses can benefit from special care.

The patient at hand was hospitalized at the rheumatology department after experiencing some pain and stiffness for a few days. Before starting any examination or therapy, the patient was informed about the project and voluntarily signed the consent form (Annex 2), which the Ethics Committee of Charles University approved (Annex 1).

The patient had one therapy session per day; I performed the therapy every morning until the very last day of his stay at the hospital under the supervision and guidance of my supervisor. The initial and final examinations were conducted at the beginning of the first and last sessions, respectively. After the initial examination, a therapy plan was conducted, including short and long-term goals.

The three-year bachelor's degree program in physiotherapy at Charles University FTVS covered the physiotherapeutic techniques employed during the therapy sessions. The therapeutic techniques and examinations operated throughout the therapy sessions included:

- Soft tissue techniques,
- Deep stabilization system training
- Passive stretching
- PNF according to Kabat
- Post-Isometric Relaxation (PIR)
- Joint play mobilization according to Lewit
- Foam balling according to Jebavá
- Respiratory therapy

The devices included: one goniometer, one measuring tape, one neurological hammer, and one foam ball.

3.2 Anamnesis

Examined patient: J.D.B **-** Male

Date of birth 1992

3.2.1 Diagnosis

- The patient first came to the hospital after being suspected of rheumatologic disease because of being positive for ankylosing spondylitis in his family.
- After being hospitalized and receiving medical attention, his pain reduced after obtaining Non-steroidal anti-inflammatory drugs (NSAIDs).
- His temperature was 38-39° C.
- According to his family history, the doctor's first diagnosis of the patient was ankylosing spondylitis.

3.2.2 Chief complaint/problem **(According to the first day of hospitalisation "13.01.2022".)**

- The patient's main complaint was a sharp pain in his right knee and left ankle. He described the pain as 8/10 on a pain scale of 0 to 10. But after receiving pain killers the pain reduced to 3/10 in a pain scale.
- Initially, he also complained about the limited mobility of the Lower Extremity (mainly in the ankle)
- The patient experienced swelling on his right knee and left ankle.
- The patient mentioned that he has pain in his groin bilaterally without lymphadenopathy and skin changes.

3.2.3 Personal anamnesis (PA)

- The patient described himself as a healthy, active individual who had no serious issues in the past except having minor surgeries when he was six years old and injuries in his school years due to playing sports.
- He mentioned that he visited the physiotherapist in case of pain and took medications such as pain killers if necessary.

3.2.4 Family Anamnesis (FA)

- Father and uncle had rheumatology disease.
- There was a history of heart disease in the family of his mother.

3.2.5 Surgeries

- He had an operation on his ear when he was six years old.

3.2.6 Injuries

- He had several injuries because of playing football in his adolescence in his right shoulder, wrist and right ankle.

3.2.7 Sports

- The patient is an active individual. He likes to ride a bicycle and work out in the gym up to four times a week.
- In October of 2021, he used to ride his bike for at least 30 km a day for few times a week.

3.2.8 Occupational/Social Anamnesis (OA)

- The patient is the Financial Manager of a private company.

3.2.9 Epidemiological Anamnesis (EA)

- The patient received 3 doses of the vaccination against SARS-CoV-2. He received his last shot of the vaccine on February 2022.

3.2.10 Past Rehabilitation Anamnesis

- The patient mentioned that he had a few physiotherapy sessions for minor issues in the past, but he did not remember the exact therapy used in the session. Still, he recognized that the pain was because of his hamstrings six years ago.

3.2.11 Addictions Anamnesis (Abuses)

- He used to be a smoker for six years, but he quit smoking in 2020; The patient also consumes alcohol occasionally during the weekends.

3.2.12 Allergies Anamnesis

- Nuts, peanuts
- Dairy (milk products)
- Dust, blossom
- Cats

3.2.13 Gynaecology Anamnesis (GA)

- No gynaecological tests have been undertaken.

3.2.14 Diet

- He informed us that his diet is high in protein and he is trying to consume healthy foods more frequently than before.

3.2.15 Excerpt from patient's health care file

- In SI joint, there is only the possibility of kortikalis on the left.
- There is dextroskoliosis, the possibility of kyphosis, and no other changes or pathologies for the C spine.
- For the Th spine, there is dextroscoliosis as well, flattening out kyphosis without syndesmophytes.
- There is sinistraskoliosis, kyphosis, and small Schromlov nodes on vertebral bodies without syndesmophytes for the lumbosacral part.
- Knees are in correct alignment in joints, the articular cleft is wide, and ossification of quadriceps insertion on the left.
- Heart & lungs - the diaphragm angles are free. Both lung wings have transparency; lung parenchyma is without any pathologies. Bronchovascular painting is average. Heart shadow has a standard shape (size) and configuration. The mediastinum is the midline, not enlarged.
- The talocrural joint is without changes.

3.2.16 Physiotherapy Indications

- Mobilisation of restricted areas according to Lewit.
- Post-Isomertric Relaxation (PIR) with subsequent stretching according to Lewit.
- Stretching of the possible shortened muscles.
- Respiratory physiotherapy exercises.
- Activate and strengthen the deep stabilisation system.
- Participation in group exercises.
- Electrotherapy

3.2.17 Differential according to the Main Diagnosis

After being diagnosed with ankylosing spondylitis, different joints may get involved according to the type of the disease, which may be peripheral or central.

His main complaint started from the pain localized in his peripheral joints, such as the ankle and knee, but by considering his disease, his spine was the second area to pay attention to.

3.3 Initial Kinesiological examination

The examination was performed on 14/02/2022.

Present Status:

- **Subjective:**

The patient was fully aware, and he could communicate verbally. He informed my supervisor and me that he's currently having pain in his right knee and left ankle; the pain was followed by swelling in those locations. He experienced the pain while standing, and sitting was described with no pain and other difficulties. He also mentioned that the pain is generally worse in the morning in comparison with the rest of the day.

- **Objective:**

The patient was hospitalized in the Department of Rheumatology on 13.01.2022. During examination and when reading the consent form, the patient wore glasses and signed it without any issues. The patient followed conversations well and seemed oriented in time, space, and self.

- Height: 194 cm
- Weight: 97 kg
- BMI, BSA, somatotype: 25.8, 2.29m^2, Endomorph
- Heart rate: 82 beats/min
- Temperature: 36.5 ° C
- Respiratory rate: 14 breaths/min
- Extra observations:
    - The patient requires glasses and one crutch he mentioned that the 2nd crutch is at home.
    - He is left-handed.

3.3.1 Static Postural Examination

This examination is typically indicated in a standing position; however, we start performing the examination in standing, but due to the patient's condition, he faced some pain that we had to let him rest while sitting on a table and after resting for a few minutes asking him to stand up for continuing the examination. Within this regard, the static segmental examination was carried out in bed while the patient was supine and without the use of any pillows or other tools; the results are on the next page.

- Slightly unstable
- The skeletal muscles seem to be both hypertonic and hypertrophic.
- The Thoracic spine shows kyphotic.
- Slight lordosis of the Lumbar spine.
- Abdominal wall seems to be slightly relaxed.
- Head is slightly shifted forward.

Upper extremity:

- Shoulders seems to be protracted and have the tendency to move forward.
- His left shoulder seems to be more elevated for 1 cm.
- The chest muscles are not symmetrical, right one seems to be larger.
- Both elbows were in semiflexion.
- His wrists and hands were in neutral position.
- All IP and MCP joints are in semiflexion while we asked him to relax.

Lower extremity:

- There is no sign of flat feet on either foot; there is more space under his right foot compared to the left one.
- The heels are rotated inward while standing. (External rotation in both hips.)
- There is no sign of hyperextension in the knees while standing.
- There is no sign of Valgus or Varus knees; They seem to be normal.

3.3.2 Assessment of Breathing Stereotype

Breathing patterns are measured during this test normally in three different positions: lying on the bed, sitting on the bed, and finally standing up without the use of any cushions or other other helping devices. Examining, palpating, and listening revealed that the patient was mostly breathing within upper thoracic area.

He started the breathing wave in the lower thoracic area during the inhalation, though, as he realized we were observing his breathing rhythm. At the conclusion of the inhalation, he proceeded gradually ventrally and cranially to the upper thoracic area. As it proceeded caudally to the lower thoracic area, exhalation also started largely in the upper thoracic area. Throughout the duration of the breathing wave, the abdominal region was neither felt nor visible.

Deep breathing was noticed mostly in the upper thoracic area. Since the right side was more noticeable when palpated, it was not symmetrical. The intensity of the breathing was roughly 1 cm, and the frequency was 14 breaths per minute.

3.3.3 Specific testing of posture

a. Two scale standing: 42.5 kg on the left side, 54,5 kg on the right side
   - 15% of total weight = 14.55 kg
   - The weight difference in the two-scale stand test is 12 kg, the patient is in the normal range.

b. Romberg test:
   - I. Negative
   - II. Negative
   - III. Slightly side to side, minimal shaking.

c. Single leg stance:
   - Left: The patient was not able to perform the test.
   - Right: Minimal ankle twitch; good overall stability.

d. Trendelenburg's sign:
   - Left: Negative
   - Right: Negative

e. Vele test:
   - Grade III: Moderate impaired stability with claw toes

3.3.4 Modification of Standing

- Standing on tiptoes: The patient could not stand on his tiptoes because of the pain, mainly in his left ankle.
- Standing on heels: Good stability in both feet and legs.

3.3.5 Gait Examination

- Due to the patient's condition in the morning before taking his medications, he did find himself comfortable with testing his gait pattern because of the pain in his left ankle and right knee.

3.3.6 Spinal Distances:

Spinal distance Test	Result	Normal Range
Thomayer's test	49 cm	0 cm +/-
Shoeber distance	4 cm	5 cm
Stibor's distance	11 cm	7 – 10 cm
Forestier Fleche	4 cm	0 cm
Lateral-latero flexion	left side – 30 cm	20 – 25 cm
	right side - 29 cm	

Table 10. Spinal Distances

3.3.7 Examination of movement patterns by Janda

- Hip joint Extension: Engagement of Gluteus muscles bilaterally.
- Hip joint Abduction: He has the tendency to move into flexion and external rotation while performing the abduction on the both sides bilaterally.
- Shoulder joint Abduction: Hyper activation of Upper Trapezius muscle.
- Neck Flexion: Hyper activation of Sternocleidomastoid (SCM), Chin - Sternum distance was 2 cm.

3.3.8 Anthropometric measurements (Length & Circumference)

Length						Circumference					
LE anatomical	76.5 cm Left		77 cm Right			Thigh 15cm above knee	L 52 cm		Thigh 10 cm above knee cap	L 50 cm	
LE functional	SIAS		Left 95 cm	Right 95 cm			R 53.5 cm			R 51.5 cm	
	Umbilicual		Left 103 cm	Right 103 cm							
	Left	Righ		Left	Right		Left	Right		Left	Right
Thigh	39 cm	36 cm	Middle leg	34 cm	34 cm	Knee joint	45 cm	45 cm	Tuberositas tibae	31 cm	31 cm
Foot	23.5 cm	23 cm				Calf	42.5 cm	42 cm	Ankle joint	25 cm	23.5 cm
						Heel	35 cm	33 cm	Foot	21 cm	20.5 cm
Whole UE	74 cm	74 cm	Humerus	26 cm	27 cm	Metatarsal	26 cm	25 cm	Elbow	31 cm	31 cm
Forearm	24.5 cm	23 cm	Hand	21 Cm	21 cm	Upper arm (relaxed)	29 cm	28.5 cm	Forearm	27 cm	27 cm
						Upper arm (flexed)	32 cm	31 cm	Wrist	23 cm	23 cm

Table 11. Anthropometric measurements of Lower Extremities (Length & Circumference)

3.3.9 Soft tissue examination by Lewit

- Examination of the fascia of the lower extremities:
  - The medial and anterior fascia in the cranial and caudal orientations of the right hip is slightly constricted. Slight constraints and the other directions were visible upon examination of the fascia in the lateral section. Additionally, there is a minor medial restriction in the calf fascia.
- Superficial layers of skin:
  - The back of the thigh is slightly restricted. On the anterior, lateral, and medial portions of the thigh, there is a cutaneous limitation in the caudal, cranial, medial, and lateral directions.

3.3.10 Muscle tone examination

Tested Muscle	Left	Right
Quadriceps femoris muscle (rectus femoris, vastus medialis, vastus intermedius, vastus lateralis)	Hypertone	Hypertone
Gluteal muscles (Gluteus medius, Gluteus maximus)	Hypertone	Normal
Hamstrings	Hypertone	Hypertone
Adductors (Adductor magnus, brevis, longus, gracilis, pectineus)	Hypertone +	Hypertone
Iliopsoas muscle	Hypertone	Hypertone+
Tensor fasciae latae	Hypertone +	Hypertone+

Table 12. Muscle tone Examination

3.3.11 Muscle strength test according Janda

Tested Muscle	Left	Right
Quadriceps femoris muscle	5	4
Gluteus minimus and maximus	4	4
Hamstrings	4	4
Hip abductors (gluteus maximus and tensor fascia latae)	5	5
Adductors	4	4
Ankle dorsal flexors	3	4
Ankle plantar flexors	4	4
Hip flexors	5	5

Table 13. Muscle Strength test Examination

- The patient used to engage in a lot of physical exercise on a regular basis, therefore his strength test results appear to be high and in good condition.

3.3.12 Goniometric Examination by Janda

- ROM was made using a plastic goniometer.

Hip Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
S	o o o 15 – 0 – 135	o o o 15 – 0 – 135	o o o 10 – 0 – 135	o o o 15 – 0 – 135
F	o o o 25 – 0 – 15	o o o 30 – 0 – 20	o o o 30 – 0 – 20	o o o 35 – 0 – 25
R	o o o 10 – 0 – 5	o o o 15 – 0 – 10	o o o 40 – 0 – 5	o o o 45 – 0 – 10

Table 14. Goniometric examination of Hip joint by Janda

Knee Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
S	o o o 0 – 0 – 125	o o o 0 – 0 – 130	o o o 0 – 0 – 135	o o o 0 – 0 – 135

Table 15. Goniometric examination of Knee joint by Janda

Ankle Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
S	o o o 0 – 0 – 45	o o o 0 – 0 – 50	o o o 10 – 0 – 40	o o o 15 – 0 – 45
R	o o o 10 – 0 – 15	o o 15 – 0 – 20	o o o 20 – 0 – 25	o o o 25 – 0 – 30

Table 16. Goniometric examination of Ankle joint by Janda

Shoulder Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
S	o o o 40 – 0 – 175	o o o 45 – 0 – 180	o o o 45 – 0 – 170	o o o 45 – 0 – 180
F	o o o 0 – 0 – 170	o o o 0 – 0 – 180	o o o 0 – 0 – 165	o o o 0 – 0 – 180
T	o o o 40 – 0 – 70	o o o 40 – 0 – 90	o o o 40 – 0 – 70	o o o 40 – 0 – 90
R	o o o 65 – 0 – 20	o o o 70 – 0 – 20	o o o 60 – 0 – 35	o o o 65 – 0 – 35

Table 17. Goniometric examination of Shoulder joint by Janda

Elbow Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
S	o o o 0 – 0 – 145	o o o 0 – 0 – 145	o o o 0 – 0 – 145	o o o 0 – 0 – 145

Table 18. Goniometric examination of Elbow joint by Janda

Radio Ulnar Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
F	o o o 15 – 0 – 30	o o o 15 – 0 – 30	o o o 15 – 0 – 30	o o o 15 – 0 – 35

Table 19. Goniometric examination of Radio Ulnar joint by Janda

Wrist Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
S	o o o 75 – 0 – 80	o o o 75 – 0 – 85	o o o 75 – 0 – 80	o o o 80 – 0 – 85
R	o o o 80 – 0 – 90	o o o 80 – 0 – 90	o o o 85 – 0 –90	o o o 90 – 0 – 90

Table 20. Goniometric examination of Wrist joint by Janda

3.3.13 Joint play examination by Lewit

Joint	Left	Right
Patella (medial, laterao lateral, cranial and caudal directions)	Not Restricted	Restricted, mostly in cranial & caudal direction
Tibiofibular joint in dorsal and ventral directions	Not Restricted	Restricted in both directions
Talocrural joint in dorsal and ventral directions	Restricted in all directions	Restricted in all directions
Lisfranc's joint in dorsal and ventral directions	Restricted in all directions	Restricted in all directions
Chopart's joint in ventral and dorsal directions	Restricted in all directions	Restricted in all directions
Metatarsophalangeal joints in plantar, dorsal and lateral directions	Restricted in all directions (mostly in plantar and dorsal directions)	Restricted in all directions
Interphalangeal joints in plantar, dorsal and lateral directions	Restricted in all directions	Not Restricted

Table 21. Joint play examination by Lewit

3.3.14 Muscle Length Examination by Janda

Examined muscle	Left extremely	Right Extremity
Soleus	Grade 2	Grade 1
Gastrocnemius	Grade 2	Grade 1
Adductors of hip	Grade 1	Grade 1
Piriformis	Grade 1	Grade 2
Hip Flexors (one joint)	Grade 2	Grade 2
Hip Flexors (two Joints)	Grade 2	Grade 2
Hamstrings	Grade 2	Grade 2
Pectoralis major (Clavicular part)	Grade 2	Grade 2
Pectoralis major (Sternal part)	Grade 1	Grade 2
Pectoralis minor	Grade 2	Grade 2
Trapezius (Cranial Part)	Grade 2 (Hard end-feel)	Grade 1
SCM	Shortness (Hard end-feel)	Shortness (Hard end-feel)

Table 22. Muscle Length test of LE by Janda

3.3.15 Hypermobility Examination

Examination	Left	Right
Passive dorsiflexion and hyperextension of the fifth MCP joint beyond 90°	0	0
Passive apposition of the thumb to the flexor aspect of the forearm	0	0
Passive hyperextension of the elbow beyond 10°	0	0
Passive hyperextension of the knee beyond 10°	0	0
Active forward flexion of the trunk with the knees fully extended so that the palms of the hands rest flat on the floor	0	

Table 23. Hypermobility examination according to Beighton Score

- The patient's BEI score was 0 from 9 since he was unable to complete any of the aforementioned assessments.

3.3.16 Neurological Examinations

- **Dermatomes Examination:**

Light touch was used to analyze the skin's surface sensation on particular dermatomes on both lower extremities.The result of the sensation and patient's feelings were assessed on the following page:

Dermatome of the segment	Left	Right
Dermatome of the L1 segment	Normal sensation has been felt	Normal sensation has been felt
Dermatome of the L2 segment	Normal sensation has been felt	Normal sensation has been felt
Dermatome of the L3 segment	Normal sensation has been felt	Normal sensation has been felt
Dermatome of the L4 segment	Normal sensation has been felt	Normal sensation has been felt
Dermatome of the L5 segment	Normal sensation has been felt	Normal sensation has been felt
Dermatome of the S1 segment	Normal sensation has been felt	Normal sensation has been felt
Dermatome of the S2 segment	Normal sensation has been felt	Normal sensation has been felt

Table 24. Dermatomes Examination

- **Cranial Nerves Examinations**

I. Olfactory Nerve:

The patient successfully could identify the smell of coffee and the perfume that we have used for testing.

II. Optic Nerve:

The patient was able to define various colors, and he could comprehend with his eyewear (even caled-down sentences).

III. Oculomotor nerve:

The patient was also capable of cross pattern motions such as glancing up and down and from one side to the other. When the flashlight was shone into the patient's eyes, both pupils responded simultaneously.

IV. Trochlear Nerve:

The patient mentioned that he never had double vision, and there was no sign of notable head tilt.

V. Trigeminal Nerve:

After conducting the hands of my supervisor on the patient’s face (from the lateral edges of the forehead to the cheeks), the patient declared that it felt the same on both sides.

VI. Abducens Nerve:

The same test as the oculomotor examination was performed, and one more time, the result of the test was negative; the patient had no restriction with his eye movements.

VII. Facial Nerve:

We asked the patient to make different facial expressions such as: firstly to make a smiley face, secondly to raise his eyebrows, and finally to blow up his cheeks. The patient was successful in all of the movements above without facing any kind of restrictions.

VIII. Vestibulocochlear Nerve:

The patient had no trouble hearing and communicating during the entire therapy session. He also showed sufficient awareness relative to his age.

IX. Glossopharyngeal nerve:

We asked the patient to swallow and make a simple sound like an “ah” sound. He did this without facing any concerns.

X. Vagus Nerve:

This test was identical to the previous examination, which was also negative.

XI. Accessory Nerve:

When asked to shrug and look left and right, the patient showed symmetrical movements in all of the requested tests.

XII. Hypoglossal Nerve:

We asked the patient to protrude his tongue, move his tongue laterally, put his tongue against his cheek, and resist the force of the therapist's hand resting on the external cheek. The patient successfully performed the procedure without facing any difficulties.

All the cranial nerves created negative results, indicating no concerns or pathologies.

Deep Tendon Examination:

Reflex	Left Extremity	Right Extremity
Biceps	Normal	Normal
Triceps	Normal	Normal
Bracoradialis	Normal	Normal

Table 25. Deep Tendon Reflexes of UE

Reflex	Left Extremity	Right Extremity
Patellar	Normal	Normal
Achilles	Normal	Normal
Medioplantar	Normal	Normal

Table 26. Deep Tendon Reflexes of LE

Deep Sensation Examination:

We examined the deep sensation via Position and Movement sense. The patient was able to sense and locate successfully in both lower and upper extremities, which is an indication of no pathologies.

Examination of Pyramidal Signs:

- Lower Extremity:
  - Babinski: Negative
  - Chaddock: Negative
  - Rossolimo: Negative
- Upper Extremity:
  - Huffman: Negative
  - Juster: Negative
  - Trömner: Negative

3.3.17 Initial Examination Conclusion

The patient managed well during the kinesiological examinations; He did not feel tired. He was motivated to participate in all examinations to find the problematic areas. All of the examinations together indicated no severe matter that needs to be dealt with immediately. His postural examinations indicated some issues that may be related to his office job, such as protracted shoulders and shortened pectoral muscles (pectoralis major and minor).

Since the patient could not walk in order for us to examine his gait pattern due to pain in his ankle and knee, Enhancing his gait pattern by reducing the pain localized in the targeted areas will be one of the leading short-term goals of the therapy sessions. Furthermore, according to the joint play examination according to Lewit, the results indicated that there are many restrictions in the majority of the lower extremity joints, which can be one of the main reasons for the pain.

That being said, the muscle length test examination, according to Janda and Kendall, also showed shortness of the related muscles to the restricted joints in both lower extremities; this can be because of the physical activity that the patient used to have especially since he mentioned that he used to ride his bicycle for 25-30 km a day during the winter without stretching his muscles afterward.

3.4 Short-term & long-term Physiotherapeutic plan

3.4.1 Short-Term Physiotherapeutic Plan

- Reduce the pain in his right knee and left ankle.
- Thromboembolic prevention
- Decrease swelling (edema)
- Improve mobility of fascias on the right thigh and calf and mobility of the skin.
- Mobilization and increasing the joint play of the restricted joints (tibiofibular, talocrural, MTT, TC, and patella.) especially in his left ankle.
- Increase ROM in hip and ankle joints.
- Relax hypertonic muscles.
- Stretch shortened muscles.
- Maintain the cutest ROM.
- Prevent the muscles from atrophy.
  - Conditional training by employing active movement against resistance (gravity, weights, resistance band, etc.)
- Improve the gait pattern with the special focus on walking on the stairs.
- Improve stability.
- Activate the deep stabilization system

3.4.2 Long-Term Physiotherapeutic Plan

- Enhance the breathing pattern.
- Focus on improving the wrong stereotypes such as hip and shoulder joint movements.
- Additional muscle stretch.
- Additional muscle relaxation.

3.5 Therapy Progress

1. Therapy -14 /01/2022

Patient status:

- Today's session is one day after my patient's hospitalization.
- The patient has a good mood and feels motivated for the therapy session.
- The patient received medication in the morning after having his breakfast; therefore, he felt no pain by the time he was having physiotherapy.
- We have been informed that the responsible doctor for the patient will visit the patient after the therapy session; therefore, today's session will not be as long as usual.

Goals of today's therapy session:

- Thromboembolic prevention.
- Decrease swelling on the left ankle.
- Relax the hypertonic muscles.
- Stretch the lower extremity shortened muscles.
- Increase the ROM in both lower extremities where there is a limitation (mainly in the ankles)
- Increase the Joint play mobility of the restricted joints.

Therapy Proposal:

- We initiated today's therapy session with thromboembolic prevention exercises. The patient performed active plantar and dorsal flexion of the ankle and circular movements of the foot in the supine position for 20 repetitions.
- Subsequently, lymphatic massage was applied with a softball, pushing and turning to the right and left sides of the foot (massage applied from distal to proximal direction using the small ball.)
- Mobilization of restricted joints according to Lewit:
  - Mobilization of metatarsophalangeal and interphalangeal joints in all directions on the left and then right side.
  - Mobilization of Lisfranc and Chopart joints in all directions on the left and then the right side.
  - Talocrural joint in ventral and dorsal direction on the left and then the right side.

- Mobilization of patella in all directions (lateral, medial, caudal and cranial) in supine position with extended knee. (Starting with the right patella and finishing with the left patella.)

- Passive stretch by the physiotherapist for the lower extremity shortened muscles:
  - Hamstrings, hip adductors and quadriceps femoris on both sides.
- Using Post-Isometric-Relaxation (PIR) technique for increasing the relaxation of the hypertonic muscles:
  - Hip adductors, quadriceps femoris, iliopsoas on both sides.
- Soft tissue technique, according to Lewit, in the Lateral direction of the right thigh and the left thigh afterward. And performing the soft tissue technique for the fascia of the left calf.
- Since the patient could perform the movements actively without any restrictions, no passive movement has applied.
  - Active movements in order to increase ROM in the hip, knee and ankle joints in supine.
  - Flexion and extension of the knee using a light resistance band in both legs (while there is a large ball under both knees). The patient was instructed to perform the movement and pay attention to keep his lower leg in one straight line. The patient performed the exercises for 3 sets, 12 repetition for each leg individually)
  - Same as flexion, the patient was asked to do hip abduction keeping in mind to keep the leg in one line and avoid the leg from moving to flexion.
  - While staying in supine position, the patient was asked to perform dorsiflexion and plantar flexion of the ankle joint while having his knees bent (3 sets, 15 repetitions).

Results:

- The patient was satisfied after the therapy session, but he mentioned that he did not feel tired. However he informed us of the pain he felt while passively stretching the hamstrings and using the PIR technique for the relaxation of adductors.

Self-Therapy:

- The patient was instructed to practice the self-therapy PIR technique for his adductors during the day and start walking again with crutches since he is not feeling as much pain as before because of the medications.

2. Therapy - 17/01/2022

Patient status:

- The patient has a good mood and feels motivated like the previous session.
- The patient informed us that he is feeling pain while walking with the crutches on his right knee and the left ankle, and in case of removing the crutches, the pain is released according to the patient.
- The swelling on his left ankle seems to be slightly better.
- While standing, he seems to be unstable.

Goals of today's therapy session:

- Thromboembolic prevention.
- Decrease swelling on the left ankle.
- Continue relaxing the hypertonic muscles.
- Continue stretching the lower extremity shortened muscles.
- Increase the ROM in both lower extremities where there is a limitation (mainly in the ankles)
- Increase the Joint play mobility of the restricted joints.
- Activate the deep stabilisation system.

Therapy Proposal:

- We initiated today's therapy session similar to the previous with thromboembolic prevention exercises. The patient performed active plantar and dorsal flexion of the ankle and circular movements of the foot in the supine position for 20 repetitions.
- Subsequently, lymphatic massage was applied with a softball, pushing and turning to the right and left sides of the foot (massage applied from distal to proximal direction using the small ball in circular motions.) and moving up toward the lateral side of calf muscles and finishing the massage while being at the proximal part of the thigh.
- Mobilization of restricted joints according to Lewit:
    - I am starting to mobilize metatarsophalangeal and interphalangeal joints in all directions on the left and right sides.
    - Mobilization of Lisfranc and Chopart joints in all directions on the left and right sides.
    - Talocrural joint in ventral and dorsal direction on the left and right side.

- Mobilization of the patella in all directions (lateral, medial, caudal, and cranial) in a supine position with an extended knee. (Starting with the right patella and finishing with the left patella.)

- Passive stretch by the physiotherapist for the lower extremity shortened muscles:
  - Hamstrings, hip adductors, and quadriceps femoris on both sides.
- Using the Post-Isometric-Relaxation (PIR) technique according to lewit for increasing the relaxation of the hypertonic muscles:
  - Hip adductors, quadriceps femoris, and iliopsoas on both sides.
  - Soleus muscle relaxation via the PIR technique in both sides with the main focus on the left side.
  - Gluteus maximus muscles relaxation with PIR, because of having hypertonic muscles.
  - Biceps femoris PIR with passive stretching in the end. (3 repetition with deep and long inhalation and exhalation according to PIR technique principles.)
- Soft tissue technique, according to Lewit, in the Lateral direction of the right thigh and the left thigh afterward. Moreover, performing the soft tissue technique for the fascia of the left calf.
- Since the patient could perform the movements actively without any restrictions, no passive movement has applied.
  - Active movements in order to increase ROM in the hip, knee, and ankle joints in supine.
  - Flexion and extension of the knee using a light resistance band in both legs (while there is a large ball under both knees). The patient was instructed to perform the movement and pay attention to keep his lower leg in one straight line. The patient performed the exercises for 3 sets, 12 repetitions for each leg individually)
  - Same as flexion, the patient was asked to do hip abduction keeping in mind to keep the leg in one line and avoid the leg from moving to flexion.
  - While staying supine, the patient was asked to perform dorsiflexion and plantar flexion of the ankle joint while having his knees bent (3 sets, 15 repetitions).
- Activating the deep stabilization system, according to Kendall, By asking the patient to remain supine, now without having to touch the skin, by positioning both hands on the lower lateral edge of the abdominal muscles. Additionally, I will encourage the patient to

breathe deeply under my hands to activate the lower abdominal muscles, and as inspiration comes to a close, I will gently push the lower abdominal muscles to improve expiration.

Results:

Same as the previous therapy session, the patient felt discomfort. In contrast, passive stretching exercises such as hip adductors and hamstrings, but the exercise he felt the most was the PIR and passive stretch of the biceps femoris. However, he mentioned that he felt the release and relaxation after finishing and moving on to the next exercise.

That being said, the joint-play restriction present in his lower extremity seems to be better, but the swelling (edema) in his left ankle is still present. However, according to today's therapy session, the right knee has more minor swelling than the ankle, and it seems to be more mobile.

Self-Therapy:

- Likewise, the patient mentioned that he feels more comfortable walking without the crutches. My supervisor advised him to keep using the crutches.
- We also instructed him to keep performing the PIR for the adductors and also educated him to preform self therapy PIR for the gluteal muscles in order to reduce the tone and increase the relaxation.

3. Therapy - 18/01/2022

Patient status:

- The patient entered the therapy room with a good mood.
- Using optical inspection, the edema in the right knee and left ankle has greatly reduced.
- Measuring the circumference of the left ankle and right quadriceps shows that the swelling has improved:
    - The left ankle used to be 25 cm, and the right thigh (15cm above the knee cap) was 53.5 cm on the initial kinesiological examination, and now the left ankle is 24.5 cm, and the right thigh is 53 cm.
- The patient described less pain compared to the previous days. Nevertheless, before he receives the medication daily, the pain seems to be more and can cause discomfort for the patient, especially in the morning.
- Examination of restricted joints on the left side according to Lewit:
    - Metatarsophalangeal and interphalangeal joints of the left are less restricted. By comparing with the other side, the right side is not restricted.

- **Gait examination:**
    - The patient is walking with forearm crutches (french), and he is using the 3- point alternate gait.
    - He is walking with a small base of support.
    - He has a non-periodic walking tempo.
    - He has a slow walking speed, but he is taking a large step at a time; also, he is being careful, and he does not want to put so much weight on his left ankle. That being said, the length of his steps is also not symmetrical.
    - It seems that he tends to have Heel strike-Early flat foot on both sides. The left ankle does not go into dorsiflexion; however, it did not drop either (drop foot) the activation of tibialis anterior.
    - The right leg sometimes goes into external rotation.
    - There was no sign of valgosity or varusity of the knees.
    - Slight flexion of the trunk during walking.
    - Shoulders are slightly elevated due to the usage of the crutches. Moreover, There was no gesture of the head.
    - He was stable while he was walking. (no sign of shaking or shifting from side to side.)

Goals of today's therapy session:

- Thromboembolic prevention.
- Improve the mobility of fascia and skin on the right thigh.
- Increase the relaxation of hypertonic muscles.
- Stretch shortened muscles. (introducing the passive stretching into upper extremity muscles, starting with pectoralis major and minor)
- Increase ROM in both lower extremities where it is limited (mainly in both hips and the left ankle).
- Gait exercises by practicing Walking up the stairs.
- Continue practicing the activation of the deep stabilization system.

Therapy Proposal:

- Like the previous sessions, today's therapy session started with thromboembolic prevention exercises. The patient performed active plantar and dorsal flexion of the ankle and circular movements of the foot in the supine position for 20 repetitions.
- Subsequently, lymphatic massage was applied with a softball, pushing and turning to the right and left sides of the foot (massage applied from distal to proximal direction using the small ball in circular motions.) and moving up toward the lateral side of calf muscles and finishing the massage while being at the proximal part of the thigh.
- Mobilization of restricted joints according to Lewit:
  - Starting with the mobilization of metatarsophalangeal and interphalangeal joints in all directions on the left and right sides.
  - Mobilization of Lisfranc and Chopart joints in all directions on the left and right sides.
  - Talocrural joint in ventral and dorsal direction on the left and right side.
  - Mobilization of the patella in all directions (lateral, medial, caudal, and cranial) in a supine position with an extended knee. (Starting with the right patella and finishing with the left patella.)
- Passive stretching exercises for the lower extremity and upper extremity shortened muscles:
  - Hamstrings, hip adductors, and quadriceps femoris on both sides.
  - According to Janda, the passive stretching of the pectoral major and passive stretching of the pectoralis minor, according to Kendall.
- Using the Post-Isometric-Relaxation (PIR) technique according to lewit for increasing the relaxation of the hypertonic muscles:
  - Gluteus maximus muscles relaxation with PIR because of being hypertonic during the palpation examination.
  - Biceps femoris PIR with passive stretching in the end. (3 repetitions with deep and prolonged inhalation and exhalation according to PIR technique principles.)
- Soft tissue technique, according to Lewit, in the Lateral direction of the right and left thigh. Moreover, performing the soft tissue technique for the fascia of both calves.
- Since the patient could perform the movements actively without any restrictions, no passive movement has applied.
  - Active movements to increase and maintain the ROM in the hip, knee, and ankle joints in supine.

- Flexion and extension of the knee using a light resistance band in both legs (while there is a large ball under both knees). The patient was instructed to perform the movement and pay attention to keep his lower leg in one straight line. The patient performed the exercises for 3 sets, 12 repetitions for each leg individually)
- Same as flexion, the patient was asked to do hip abduction keeping in mind to keep the leg in one line and avoid the leg from moving to flexion.
- While staying supine, the patient was asked to perform dorsiflexion and plantar flexion of the ankle joint while having his knees bent (3 sets, 15 repetitions).

• The last exercise that was performed in the supine position was Activating the deep stabilization system, according to Kendall, by placing both hands on the lower lateral edge of the abdominal muscles but not touching the skin. By asking the patient to breathe in deeply under my hands to activate the lower abdominal muscles, I will slightly push the lower abdominal muscles to enhance the expiration by the end of inspiration.
• Ending today's therapy session by asking the patient to walk in the hallway to reach the stairs so he can climb the stairs under the supervision of two therapists, one from the side and one from behind.

Results:

Identical to the prior therapy sessions, the patient sensed pain and discomfort in exercises such as passive stretching of hip adductors and hamstrings. However, the exercise he felt the most was the PIR and passive stretch of the biceps femoris and adductors in both of his legs. However, he mentioned that he felt the release and relaxation after finishing and moving on to the next exercise. He also mentioned that the stretching in the pectoralis muscles was starting to get painful if we prolonged the stretch a bit longer.

Furthermore, the joint-play restriction present in his lower extremity seems to be better, especially on his right side (both ankles and patella joints). However, his left ankle's swelling (edema) is still present, but according to the circumference examination on the right thigh and the left, it seems that the swelling is decreasing slowly. Nevertheless, according to today's therapy session, the right knee still has less swelling than the ankle, and it seems to be more mobile.

The gait examination also showed that the patient is careful with his left ankle because he could activate the muscles to move the ankle into dorsiflexion (with or without gravity). Because of taking medication, the ankle's pain should be minor compared to a few days ago because he is not complaining about it as much as in previous sessions.

Self-Therapy:

- We reminded the patient to keep using the crutches while walking or climbing the stairs.
- We also recommended that he keep performing the PIR for the adductors and gluteus maximus muscles to reduce the tone and increase the relaxation.

4. Therapy - 19/01/2022

Patient status:

- The patient mood is good. However, he started to complain about leaving the hospital soon.
- Muscle tone examination: Improvement of quadriceps femoris and adductors of the hip.
- ROM also seemed to be better on both hip adductors and ankles. (right ankle is still in a better state than the left ankle in terms of ROM and swelling.)
- Examination of restricted joints according to Lewit:
  - Metatarsophalangeal and interphalangeal joints of the left are less restricted. Compared with the other side, the right side is not restricted the same as yesterday. Lisfranc, Chopart, and talocrural joints are restricted on the left side. However, the subtalar joint is still restricted on both lower extremities.
  - Patella joints are still restricted in both lower extremities.

Goals of today's therapy session:

- Thromboembolic prevention.
- Improve the mobility of fascia and skin on both thighs.
- Increase the relaxation of hypertonic muscles.
- Stretch the shortened muscles. (introducing the passive stretching into upper extremity muscles such as trapezius and Sternocleidomastoid muscles.)
- Increase the joint play in the restricted joints of both lower extremities Increase and maintan ROM in both lower extremities with limitation (mainly in both hips and the left ankle.)
- Gait exercises by practicing climbing up and starting to climb down the stairs.
- Continue practicing the activation of the deep stabilization system.

Therapy Proposal:

- Today's therapy session started with thromboembolic prevention exercises like the previous sessions. The patient performed active plantar and dorsal flexion of the ankle and circular movements of the foot in the supine position for 20 repetitions.
- Subsequently, lymphatic massage was applied with a softball, pushing and turning to the right and left sides of the foot (massage applied from distal to proximal direction using the small ball in circular motions.) and moving up toward the lateral side of calf muscles and finishing the massage while being at the proximal part of the thigh. (the main focus is on the left lower extremity; however, both legs received the treatment.)
- Mobilization of restricted joints according to Lewit:
  - Starting with the mobilization of metatarsophalangeal and interphalangeal joints in all directions on the left and right sides of the left leg since the right side was free.
  - Mobilization of Lisfranc and Chopart joints in all directions on the left side.
  - Talocrural joint in ventral and dorsal direction on the left and right side.
  - Mobilization of Subtalar joint in both lower extremities.
  - Mobilization of the patella in all directions (lateral, medial, caudal, and cranial) in a supine position with an extended knee. (Starting with the right patella and finishing with the left patella.)
- Passive stretching exercises for the lower extremity and upper extremity shortened muscles:
  - Hamstrings, hip adductors, and quadriceps femoris on both sides.
  - The passive stretching of the pectoral major, trapezius, SCM, according to Janda, and passive stretching of the pectoralis minor, according to Kendall.
- Using the Post-Isometric-Relaxation (PIR) technique, according to Lewit identical to the previous days for increasing the relaxation of the hypertonic muscles:
  - Gluteus maximus muscles relaxation with PIR up to 3 times
  - Biceps femoris PIR with passive stretching in the end. (3 repetitions with deep and prolonged inhalation and exhalation according to PIR technique principles in both legs)
  - Adductors relaxation in both lower extremities using PIR (against gravity and prolonged inhalation and exhalation.)
- Soft tissue technique, according to Lewit, in the Lateral direction of the right and left thigh. Moreover, performing the soft tissue technique for the fascia of both calves.

- Since the patient could perform the movements actively without any restrictions, no passive movement has applied.
  - Active movements to increase and maintain the ROM in the hip, knee, and ankle joints in supine.
  - Flexion and extension of the knee using a light resistance band in both legs (while there is a large ball under both knees). The patient was instructed to perform the movement and pay attention to keep his lower leg in one straight line. The patient performed the exercises for 3 sets, 12 repetitions for each leg individually)
  - Same as flexion, the patient was asked to do hip abduction keeping in mind to keep the leg in one line and avoid the leg from moving to flexion.
  - While staying supine, the patient was asked to perform dorsiflexion and plantar flexion of the ankle joint while having his knees bent (3 sets, 15 repetitions).
- The last exercise performed in the supine position was identical to yesterday's session. Activating the deep stabilization system, according to Kendall, by placing both hands on the lower lateral edge of the abdominal muscles but not touching the skin. By asking the patient to inhale deeply under my hands to activate the lower abdominal muscles, I will slightly push the lower abdominal muscles to enhance the expiration by the end of inspiration.
- Ending today's therapy session same as the previous day by asking the patient to walk in the hallway to reach the stairs so he can climb the stairs under the supervision of two therapists, one from the side and one from behind, and after he reaches the higher level, he will climb downstairs, again under the supervision of two therapists, one from the front and the other from the side.

Results:

Comparable to the preceding treatment sessions, the patient sensed pain and discomfort in exercises such as passive stretching of hip adductors and hamstrings. However, the exercise he felt the most pain was the PIR and passive stretch of the biceps femoris, and adductors in both of his legs. However, after finishing every repetition of the PIR exercises, the ROM slightly Increased compared to the prior repetition. Despite the pain, the patient is still motivated and continues to cooperate and follow the given instructions.

He also mentioned that the stretching in the pectoralis muscles was not as painful as in the previous session. However, the trapezius muscle was the reason for discomfort in the upper extremity. Furthermore, the joint-play restriction present in his lower extremity seems to be better, especially

on his right side (both ankles and patella joints). The edema in his left ankle is still present, but the swelling is subsiding slowly.

His gait pattern did not change as much, but it seems that the dorsiflexion was slightly increased because the patient climbed the stairs with more ease.

Self-Therapy:

Same as the end of previous sessions, we reminded the patient to:

- Keep using the crutches while walking or climbing the stairs.
- Keep performing the PIR technique for the adductors and gluteus maximus muscles to reduce the tone and increase the relaxation.
- Furthermore, finally, have some active motions in the lower extremity.

5. Therapy - 20/01/2022

Patient status:

- One week after the hospitalization of the patient.
- The patient feels good, but he still questions the physiotherapist and doctor about his release.
- The patient is working online on his devices, but since he is not feeling the pain as much as before, he started to insist that the doctors release him from the hospital.
- He arrived at the therapy room without crutches, and this event happened before in one of the previous sessions.
- He did not complain of the pain in his ankle or knees, but he mentioned that on some occasions, he might feel the pain in his left ankle; on a scale of 0-10, he gave the 4/10. However, he complained about the pain in his feet.
- He is still receiving medication during the day, and the first medication is in the morning before the daily therapy session.
- The patient also mentioned that he does not want to face any atrophy in his upper extremity muscles due to inactivity.

Therapy goals:

- Thromboembolic prevention.
- Improve the mobility of fascia and skin on both thighs.
- Increase the relaxation of hypertonic muscles.
- Introducing conditional training with resistance in the upper and Lowe extremities.

- Stretch shortened muscles. (with the focus on both upper and lower extremity shortened muscles.)
- Increase the joint play in the restricted joints in the lower extremity.
- Increase and maintain ROM in both lower extremities with limitation (mainly in both hips and the left ankle.)
- Gait exercises by practicing climbing up and starting to climb down the stairs.
- Continue practicing the activation of the deep stabilization system.

Therapy Proposal:

- Starting today's therapy session matching as the previous sessions with thromboembolic prevention exercises. The patient performed active plantar and dorsal flexion of the ankle and circular movements of the foot in the supine position for 15-20 repetitions.
- Afterward, lymphatic massage was applied identical to the rest of the therapy sessions with a softball, pushing and turning to the right and left sides of the foot (massage applied from distal to proximal direction using the small ball in circular motions.) and moving up toward the lateral side of calf muscles and finishing the massage while being at the proximal part of the thigh. (the main focus is still on the left lower extremity; however, both legs received the treatment.)
- Mobilization of restricted joints, according to Lewit (because of the patient complaint about the pain in both of his feet, the mobilization exercises were performed in most of the joints which had a history of restriction.
    - Beginning with the mobilization of metatarsophalangeal and interphalangeal joints in all directions on both legs' left and right sides.
    - Mobilization of Lisfranc and Chopart joints in all directions on both sides.
    - Talocrural joint in ventral and dorsal direction on both sides.
    - Mobilization of Subtalar joint in both sides.
    - Mobilization of the patella in all directions (lateral, medial, caudal, and cranial) in a supine position with an extended knee. A pillow was placed under the patella, keeping the patella unlocked.
- Passive stretching exercises for the lower extremity and upper extremity shortened muscles:
    - Hamstrings, hip adductors, and quadriceps femoris on both sides.

- According to Janda, the passive stretching of the pectoral major, trapezius, SCM, and passive stretching of the pectoralis minor, according to Kendall.

• Using the Post-Isometric-Relaxation (PIR) technique, according to Lewit similar to the previous days for improving the relaxation of the hypertonic muscles:
  - Gluteus maximus muscles relaxation with PIR up to 3 times.
  - Biceps femoris PIR with passive stretching in the end. (3 repetitions with deep and prolonged inhalation and exhalation according to PIR technique principles in both legs)
  - Adductors relaxation in both lower extremities using PIR (against gravity and prolonged inhalation and exhalation.)
  - Introducing the PIR technique for the soleus muscles on both sides in the prone position (3 repetitions for each side with prolonged breathing.)
• Soft tissue technique, according to Lewit, in the Lateral direction of both thighs. Moreover, performing the soft tissue technique for the fascia of both sides.
• Active movements to increase and maintain the ROM in the hip, knee, and ankle joints in supine.
  - Flexion and extension of the knee using a light resistance band in both legs (while there is a large ball under both knees). The patient was instructed to perform the movement and pay attention to keep his lower leg in one straight line. The patient performed the exercises for 3 sets, 12 repetitions for each leg individually)
  - Same as flexion, the patient was asked to do hip abduction keeping in mind to keep the leg in one line and avoid the leg from moving to flexion.
  - While staying supine, the patient was asked to perform dorsiflexion and plantar flexion of the ankle joint while having his knees bent (3 sets, 15 repetitions).
• Introducing conditional resistance training using 2 Kg dumbbells for both upper extremities:
  - The patient is holding the dumbbells with the supinated forearm, asking the patient to bend the elbows (2 sets of 12 repetitions)
  - By staying in the same position, asking the patient to rotate his forearm (so that thumb would face the ceiling), and after getting into the new position, we asked him to bend his elbow (2 sets of 12 repetitions)
  - And finally, we asked him to stay in the same position but pronate his forearm and then bend his elbow. (2 sets of 12 repetitions)

- The last exercise performed in the supine position was identical to previous sessions. Activating the deep stabilization system, according to Kendall, by placing both hands on the lower lateral edge of the abdominal muscles but not touching the skin. By asking the patient to inhale deeply under my hands to activate the lower abdominal muscles, I will slightly push the lower abdominal muscles to enhance the expiration by the end of inspiration.
- Ending today's therapy session same as the prior sessions, by giving back the crutches to the patient and asking him to use them on a daily basis. Afterwards, we asked the patient to walk in the hallway to reach the stairs so he can climb the stairs under the supervision of two therapists, one from the side and one from behind, and after he reaches the second floor, he will climb downstairs, again under the supervision of two therapists, one from the front and the other from the side.

Results:

Comparable to the preceding treatment sessions, the patient sensed pain and discomfort in exercises such as passive stretching of hip adductors and hamstrings. However, the exercise he felt the most pain was the PIR and passive stretch of the biceps femoris, and adductors in both of his legs. However, after finishing every repetition of the PIR exercises, the ROM slightly Increased compared to the prior repetition. Despite the pain, the patient is still motivated and continues to cooperate and follow the given instructions.

He also mentioned that the stretching in the pectoralis muscles was not as painful as in the previous session. However, the trapezius muscle was the reason for discomfort in the upper extremity. Furthermore, the joint-play restriction present in his lower extremity seems to be better, especially on his right side (both ankles and patella joints). The edema in his left ankle is still present, but the swelling is subsiding slowly.

His gait pattern did not change as much, but it seems that the dorsiflexion was slightly increased because the patient climbed the stairs with more ease.

Self-Therapy:

Same as the end of previous sessions, we reminded the patient to:

- Keep using the crutches while walking or climbing the stairs.
- Keep performing the PIR technique for the adductors and gluteus maximus muscles to reduce the tone and increase the relaxation.
- Furthermore, finally, have some active motions in the lower extremity.

6. Therapy - 21/01/2022

Patient status:

- Very last day of the patient's therapy session.
- The patient feels good and happy knowing that he will be able to leave the hospital.
- He arrived at the therapy room without crutches, identical to the prior sessions.
- He did not complain of the pain in his ankle or knees.
- He mentioned that the doctors agreed to release him, continue the medication daily, and receive physiotherapy a few days a week.

Goals of today's therapy session:

- romboembolic prevention.
- Improve the mobility of fascia and skin on both thighs.
- Increase the relaxation of hypertonic muscles.
- Continue with the conditional training with resistance in the upper and lower extremities.
- Stretch shortened muscles. (with the focus on both upper and lower extremity shortened muscles.)
- Increase the joint play in the restricted joints in the lower extremity.
- Increase and maintain ROM in both lower extremities with limitation (mainly in both hips and the left ankle.)
- Gait exercises by practicing climbing up and starting to climb down the stairs.
- Continue practicing the activation of the deep stabilization system.

Therapy Proposal:

Treatment techniques and methods that have been used on the final day of the patient were almost identical to the previous therapy sessions with minor changes.

- Identical as the previous day, the patient performed active plantar and dorsal flexion of the ankle and circular foot movements in the supine position for 15-20 repetitions.
- Afterward, we asked the patient to actively flex both hips while bending his knees for 10 repetitions on each leg.
- Later, the lymphatic massage was applied the same as the rest of the therapy sessions with a softball, pushing and turning to the right and left sides of the foot (massage applied from distal to proximal direction using the small ball in circular motions.) and moving up toward the lateral side of calf muscles and finishing the massage while being at the proximal part of the thigh. (the main focus is still on the left lower extremity; however, both legs received the treatment.)

- Mobilization of restricted joints, according to Lewit (because of the patient complaint concerning the pain in both of his feet, the mobilization exercises were performed in all of the joints which had a history of restriction.
  - The mobilization started with the metatarsophalangeal and interphalangeal joints in all directions on both legs' left and right sides.
  - Mobilization of Lisfranc and Chopart joints in all directions on both sides.

  Talocrural joint in ventral and dorsal direction on both sides.
  - Mobilization of Subtalar joint on both sides.
  - Mobilization of the patella in all directions (lateral, medial, caudal, and cranial) in a supine position with an extended knee. A pillow was placed under the patella, keeping the patella unlocked.
- Passive stretching exercises for the lower extremity and upper extremity shortened muscles:
  - Hamstrings, hip adductors, and quadriceps femoris on both sides.
  - Introduction of the passive stretch of piriformis muscles of both lower extremities according to Janda.
  - According to Janda, the passive stretching of the pectoral major, trapezius, SCM, and passive stretching of the pectoralis minor, according to Kendall.
- Using the Post-Isometric-Relaxation (PIR) technique, according to Lewit similar to the previous days for improving the relaxation of the hypertonic muscles:
  - Gluteus maximus muscles relaxation with PIR up to 3 times.
  - Biceps femoris PIR with passive stretching in the end. (3 repetitions with deep and prolonged inhalation and exhalation according to PIR technique principles in both legs)
  - Adductors relaxation in both lower extremities using PIR (against gravity and prolonged inhalation and exhalation.)
  - Soleus muscles relaxation using the PIR technique on both sides in the prone position (3 repetitions for each side with prolonged breathing.)
- Soft tissue technique, according to Lewit, in the Lateral direction of both thighs. Moreover, performing the soft tissue technique for the fascia of both sides.
- Active movements to increase and maintain the ROM in the hip, knee, and ankle joints in supine.
  - Flexion and extension of the knee using a light resistance band in both legs (while there is a large ball under both knees). The patient was instructed to perform the movement and pay attention to keep his lower leg in one straight line. The patient completed the exercises for 3 sets, 12 repetitions for each leg individually)

- Same as flexion, the patient was asked to do hip abduction keeping in mind to keep the leg in one line and avoid the leg from moving to flexion.
- While staying supine, the patient was asked to perform dorsiflexion and plantar flexion of the ankle joint while having his knees bent (3 sets, 15 repetitions).
- Conditional resistance training using 3 Kg dumbbells for both upper extremities:
- While the patient was holding the dumbbells with the supinated forearm, we asked the patient to bend the elbows (2 sets of 12 repetitions)
- By staying in the same position, asking the patient to rotate his forearm (so that his thumb would face the ceiling), and after getting into the new position, we asked him to bend his elbows (2 sets of 12 repetitions) and finally, we asked him to stay in the same position but pronate his forearm and bend his elbows. (2 sets of 12 repetitions)
- Activating the deep stabilization system, according to Kendall, by placing both hands on the lower lateral edge of the abdominal muscles but not touching the skin. By asking the patient to inhale deeply under my hands to activate the lower abdominal muscles, I will slightly push the lower abdominal muscles to enhance the expiration by the end of inspiration.
- Gait training exercises by climbing up and down the stairs under the supervision of two therapists.

Results:

The patient did not feel discomfort and pain in general. Moreover, the movements that used to cause pain for the patient did not generate pain today, such as the passive stretch of the hip adductors, hamstrings, and piriformis. However, the PIR of the biceps femoris was one of the exceptions that caused pain in every therapy session, which might indicate shortness, hypertonicity, or trigger points in that area. That being said, the ROM of the movements increased throughout the period that the patient was receiving therapy. He also managed to perform the active movements slowly and carefully by following the given instructions, which can improve the timing of the muscle activation according to Janda's movement stereotypes.

Furthermore, the patient had far less restrictions in the joint play mobilization treatment in the joints that used to be restricted when he first started his treatment. Also, he managed to keep his strength at a good level by exercising daily, even with increasing the resistance by using different tools. Additionally, his deep stabilization system was activated better and more efficiently, especially in his lower abdominal muscles. And finally, his gait pattern also improved by having a more upright position and improving his dorsiflexion in his left ankle.

Self-Therapy:

Since the patient was able to exercise, we have attempted to make sure that the patient was performing the exercises correctly, such as:

PIR of Adductors, gluteus maximus, and passive stretch of the pectoralis major, upper trapezius, SCM, hamstrings, and ankles.

3.6 Final Kinesiological Examination

Final examination was performed on 21/01/2022.

3.6.1 Static Postural Examination

This examination is typically indicated in a standing position; however, we start performing the examination in standing, but due to the patient's condition, he faced some pain that we had to let him rest while sitting on a table and after resting for a few minutes asking him to stand up for continuing the examination. In that sense, the static segmental examination was performed in the bed in a supine position without any pillows or other anti-decubitus instruments.

- Slightly unstable
- Skeletal muscles appear to be hypertonic and hypertrophic.
- Kyphotic is visible in the Thoracic spine.
- Slight lordosis of the Lumbar spine.
- Abdominal wall seems to be slightly relaxed.
- Head is slightly shifted forward.

Upper extremity:

- Shoulders seems to be protracted and have the tendency to move forward.
- His left shoulder seems to be more elevated for 1 cm.
- The chest muscles are not symmetrical, right one seems to be larger.
- Both elbows were in semiflexion.
- His wrists and hands were in neutral position.
- All IP and MCP joints are in semiflexion while we asked him to relax.

Lower extremity:

- There is no sign of flat feet on either foot; there is more space under his right foot compared to the left one.
- The heels are rotated inward while standing. (External rotation in both hips.)
- There is no sign of hyperextension in the knees while standing.
- There is no sign of Valgus or Varus knees; They seem to be normal.

3.6.2 Assessment of Breathing Stereotype

We perform this examination typically in multiple positions; breathing stereotypes are assessed in a supine position, sitting on the bed, and finally in a standing position without using any pads or other anti-decubitus instruments. The patient was breathing mainly through the upper thoracic region for respiration through inspection, palpation, and listening. But when he noticed that we were examining his breathing stereotype, he initiated the breathing wave in the lower thoracic region during the inhalation. He gradually moved cranially, ventrally to the upper thoracic region at the end of inhalation. Exhalation also primarily occurred in the upper thoracic area as it moved caudally to the lower thoracic region. The abdominal region was not palpable or seen throughout the whole breathing wave.

Breathing was deep and primarily felt in the upper thoracic region. It was not symmetrical as the right side was more prevalent during palpation. The breathing frequency was 14 breaths/min, and the intensity was about 1cm.

3.6.3 Specific testing of posture

a. Two scale standing: 42.5 kg on the left side, 54,5 kg on the right side
   - 15% of total weight = 14.55 kg
   - The weight difference in the two-scale stand test is 12 kg, the patient is in the normal range.

b. Romberg test:
   - I. Negative
   - II. Negative
   - III. Slight shifting side to side, minimal shaking.

c. Single leg stance:
   - Left:
   - Right: Minimal ankle twitch; good overall stability.

d. Trendelenburg's sign:
   - Left: Negative
   - Right: Negative

e. Vele test:
   - Grade III: Moderate impaired stability with claw toes

3.6.4 Modification of Standing

- Standing on tiptoes: The patient was able to stand on his tiptoes but he could not able to keep the posture for more than five seconds.
- Standing on heels: Good stability in both feet and legs.

3.6.5 Gait Examination

- The patient is adopting the 3-point alternative gait with a wider base of support whilst walking on forearm crutches (French).
- He takes wider steps when he walks.
- He puts the heel of the foot down first when stepping on it.
- The majority of the time that he walks, he is upright and not bending forward.
- The head hardly generates any motions at all when the patient is walking.
- He is steady and stable while walking.

3.6.6 Spinal Distances:

Spinal distance Test	Result	Normal Range
Thomayer's test	30 cm	0 cm +/-
Shoeber distance	3 cm	5 cm
Stibor's distance	10 cm	7 – 10 cm
Forestier Fleche	2 cm	0 cm
Lateral-latero flexion	left side – 28 cm	20 – 25 cm
	right side - 27 cm	

Table 27. Spinal Distances

3.6.7 Examination of movement patterns by Janda

- Hip joint Extension: Engagement of Gluteus muscles bilaterally.
- Hip joint Abduction: He has the tendency to move into flexion and external rotation while performing the abduction on the both sides bilaterally.
- Shoulder joint Abduction: Hyper activation of Upper Trapezius muscle.
- Neck Flexion: Hyper activation of Sternocleidomastoid (SCM), Chin - Sternum distance was 2 cm.

3.6.8 Anthropometric measurements (Length & Circumference)

Length						Circumference					
LE anatomical	76.5 cm Left		77 cm Right			Thigh 15cm above knee	L 52 cm		Thigh 10 cm above knee cap	L 50 cm	
LE functional	SIAS		Left 95 cm	Right 95 cm			R 52 cm			R 51 cm	
	Umbilicual		Left 103 cm	Right 103 cm							
	Left	Righ		Left	Right		Left	Right		Left	Right
Thigh	39 cm	36 cm	Middle leg	34 cm	34 cm	Knee joint	45 cm	45 cm	Tuberositas tibae	31 cm	31 cm
Foot	23.5 cm	23 cm				Calf	42 cm	42 cm	Ankle joint	23.5 cm	24.5 cm
						Heel	34 cm	32.5 cm	Foot	21 cm	20.5 cm
Whole UE	74 cm	74 cm	Humerus	26 cm	27 cm	Metatarsal	26 cm	25 cm	Elbow	31 cm	31 cm
Forearm	24.5 cm	23 cm	Hand	21 Cm	21 cm	Upper arm (relaxed)	28 cm	28 cm	Forearm	27 cm	27 cm
						Upper arm (flexed)	32 cm	32 cm	Wrist	23 cm	23 cm

Table 28. Anthropometric measurements of Lower Extremities (Length & Circumference)

3.6.9 Soft tissue examination by Lewit

- Examination of the fascia of the lower extremities:
  - The medial and anterior fascia in the cranial and caudal orientations of the right hip is still slightly constricted but in comparison with the the initial examination, there are improvements. Upon examination of the fascia in the lateral section, some constraints in other directions could be seen. The calf fascia also exhibits a minor medial restriction.
- Superficial layers of skin:
  - There is no limitation on the back of the thighs. On the anterior, lateral, and medial regions of the thigh, there is a cutaneous limitation in the caudal, cranial, medial, and lateral directions.

3.6.10 Muscle tone examination

Tested Muscle	Left	Right
Quadriceps femoris muscle (rectus femoris, vastus medialis, vastus intermedius, vastus lateralis)	Normal	Hypertone -
Gluteal muscles (Gluteus medius, Gluteus maximus)	Normal	Normal
Hamstrings	Hypertone -	Hypertone -
Adductors (Adductor magnus, brevis, longus, gracilis, pectineus)	Normal	Hypertone -
Iliopsoas muscle	Normal	Hypertone
Tensor fasciae latae	Hypertone	Normal

Table 29. Muscle tone Examination

3.6.11 Muscle strength test according Janda

Tested Muscle	Left	Right
Quadriceps femoris muscle	5	5
Gluteus minimus and maximus	5	5
Hamstrings	5	5
Hip abductors (gluteus maximus and tensor fascia latae)	5	5
Adductors	5	5
Ankle dorsal flexors	4	5
Ankle plantar flexors	5	5
Hip flexors	5	5

Table 30. Muscle Strength test Examination

3.6.12 Goniometric Examination by Janda

- ROM was made using a plastic goniometer.

Hip Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
S	o o o 25 – 0 – 135	o o o 30 – 0 – 135	o o o 25 – 0 – 135	o o o 30 – 0 – 135
F	o o o 40 – 0 – 20	o o o 45 – 0 – 25	o o o 35 – 0 – 25	o o o 40 – 0 – 30
R	o o o 25 – 0 – 15	o o o 30 – 0 – 20	o o o 40 – 0 – 15	o o o 45 – 0 – 20

Table 31. Goniometric examination of Hip joint by Janda

Knee Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
S	o o o 0 – 0 – 135	o o o 0 – 0 – 140	o o o 0 – 0 – 135	o o o 0 – 0 – 140

Table 32. Goniometric examination of Knee joint by Janda

Ankle Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
S	o o o 10 – 0 – 45	o o o 10 – 0 – 50	o o o 10 – 0 – 50	o o o 15 – 0 – 50
R	o o o 15 – 0 – 20	o o o 20 – 0 – 25	o o o 20 – 0 – 25	o o o 25 – 0 – 30

Table 33. Goniometric examination of Ankle joint by Janda

Shoulder Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
S	o o o 45 – 0 – 175	o o o 50 – 0 – 180	o o o 50 – 0 – 175	o o o 50 – 0 – 180
F	o o o 0 – 0 – 175	o o o 0 – 0 – 180	o o o 0 – 0 – 170	o o o 0 – 0 – 180
T	o o o 20 – 0 – 90	o o o 30 – 0 – 100	o o o 30 – 0 – 90	o o o 30 – 0 – 100
R	o o o 80 – 0 – 30	o o o 85 – 0 – 35	o o o 80 – 0 – 35	o o o 85 – 0 – 40

Table 34. Goniometric examination of Shoulder joint by Janda

Elbow Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
S	o o o 0 – 0 – 145	o o o 0 – 0 – 145	o o o 0 – 0 – 145	o o o 0 – 0 – 145

Table 35. Goniometric examination of Elbow joint by Janda

Radio Ulnar Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
F	o o o 15 – 0 – 30	o o o 20 – 0 – 35	o o o 10 – 0 – 30	o o o 15 – 0 – 35

Table 36. Goniometric examination of Radio Ulnar joint by Janda

Wrist Joint				
Plane	Left side		Right side	
	Active Movement	Passive Movement	Active Movement	Passive Movement
S	o o o 75 – 0 – 80	o o o 75 – 0 – 85	o o o 75 – 0 – 80	o o o 80 – 0 – 85
R	o o o 80 – 0 – 90	o o o 80 – 0 – 90	o o o 85 – 0 –90	o o o 90 – 0 – 90

Table 37. Goniometric examination of Wrist joint by Janda

3.6.13 Joint play examination by Lewit

Joint	Left	Right
Patella (medial, laterao lateral, cranial and caudal directions)	Not Restricted	Not Restricted
Tibiofibular joint in dorsal and ventral directions	Not Restricted	Not Restricted
Talocrural joint in dorsal and ventral directions	Restricted in all directions	Not Restricted
Lisfranc's joint in dorsal and ventral directions	Restricted in all directions	Not Restricted
Chopart's joint in ventral and dorsal directions	Restricted in all directions	Not Restricted
Metatarsophalangeal joints in plantar, dorsal and lateral directions	Not Restricted	Not Restricted
Interphalangeal joints in plantar, dorsal and lateral directions	Not Restricted	Not Restricted

Table 38. Joint play examination by Lewit

3.6.14 Muscle Length Examination by Janda

Examined muscle	Left extremely	Right Extremity
Soleus	Grade 1	Grade 1
Gastrocnemius	Grade 1	Grade 1
Adductors of hip	Grade 1	Grade 1
Piriformis	Grade 1	Grade 1
Hip Flexors (one joint)	Grade 1	Grade 1
Hip Flexors (two Joints)	Grade 1	Grade 1
Hamstrings	Grade 2	Grade 1
Pectoralis major (Clavicular part)	Grade 1	Grade 1
Pectoralis major (Sternal part)	Grade 1	Grade 1
Pectoralis minor	Grade 0 (no shortness)	Grade 0 (no shortness)
Trapezius (Cranial Part)	Grade 1	Grade 1
SCM	Grade 1	Grade 1

Table 39. Muscle Length test of LE by Janda

3.6.15 Hypermobility Examination

Examination	Left	Right
Passive dorsiflexion and hyperextension of the fifth MCP joint beyond 90°	0	0
Passive apposition of the thumb to the flexor aspect of the forearm	0	0
Passive hyperextension of the elbow beyond 10°	0	0
Passive hyperextension of the knee beyond 10°	0	0
Active forward flexion of the trunk with the knees fully extended so that the palms of the hands rest flat on the floor	0	

Table 40. Hypermobility examination according to Beighton Score

During the BEI, the patient was still unable to perform any of the tests, thus he received the score of 0/9 for his BEI, as a result.

3.6.16 Neurological Examinations

- **Dermatomes Examination:**

Dermatome of the segment	Left	Right
Dermatome of the L1 segment	Normal sensation has been felt	Normal sensation has been felt
Dermatome of the L2 segment	Normal sensation has been felt	Normal sensation has been felt
Dermatome of the L3 segment	Normal sensation has been felt	Normal sensation has been felt
Dermatome of the L4 segment	Normal sensation has been felt	Normal sensation has been felt
Dermatome of the L5 segment	Normal sensation has been felt	Normal sensation has been felt
Dermatome of the S1 segment	Normal sensation has been felt	Normal sensation has been felt
Dermatome of the S2 segment	Normal sensation has been felt	Normal sensation has been felt

Table 41. Dermatomes Examination

- **Cranial Nerves Examinations:**

I. Olfactory Nerve:

The patient successfully could identify the smell of coffee and the perfume that we have used for testing.

II. Optic Nerve:

The patient successfully defined different colours, and he could also read (even small sentences) using his glasses.

III. Oculomotor nerve:

When the flashlight was shined into the patient's eyes, both pupils responded at the same time; The patient was also capable of doing cross pattern movements such as looking up & down and from one side to the other.

IV. Trochlear Nerve:

The patient mentioned that he never had double vision, and there was no sign of notable head tilt.

V. Trigeminal Nerve:

After conducting the hands of my supervisor on the patient's face (from the lateral edges of the forehead to the cheeks), the patient declared that it felt the same on both sides.

VI. Abducens Nerve:

The same test as the oculomotor examination was performed, and one more time, the result of the test was negative; the patient had no restriction with his eye movements.

VII. Facial Nerve:

We asked the patient to make different facial expressions such as: firstly to make a smiley face, secondly to raise his eyebrows, and finally to blow up his cheeks. The patient was successful in all of the movements above without facing any kind of restrictions.

VIII. Vestibulocochlear Nerve:

Throughout the entire therapy session, there was no difficulty hearing or communicating between the patient and the therapist. Additionally, he demonstrated sufficient awareness of his surroundings

IX. Glossopharyngeal nerve:

We asked the patient to swallow and make a simple sound like an "ah" sound. He did this without facing any concerns.

X. Vagus Nerve:

This test was identical to the previous examination, which was also negative.

XI. Accessory Nerve:

When asked to shrug and look left and right, the patient showed symmetrical movements in all of the requested tests.

XII. Hypoglossal Nerve:

The patient was instructed to stick out his tongue, move it laterally, press it up against his face, and resist the pressure of the therapist's palm on the patient's outer cheek. Without any issues, the patient completed the procedure successfully.

All of the cranial nerves generated negative results, showing no abnormalities or concerns.

Deep Tendon Examination:

Reflex	Left Extremity	Right Extremity
Biceps	Normal	Normal
Triceps	Normal	Normal
Bracoradialis	Normal	Normal

Table 42. Deep Tendon Reflexes of UE

Reflex	Left Extremity	Right Extremity
Patellar	Normal	Normal
Achilles	Normal	Normal
Medioplantar	Normal	Normal

Table 43. Deep Tendon Reflexes of LE

Deep Sensation Examination:

We examined the deep sensation via Position and Movement sense. The patient was able to sense and locate successfully in both lower and upper extremities, which is an indication of no pathologies.

Examination of Pyramidal Signs:

- Lower Extremity:
  - Babinski: Negative
  - Chaddock: Negative
  - Rossolimo: Negative
- Upper Extremity:
  - Huffman: Negative
  - Juster: Negative
  - Trömner: Negative

3.7 Evaluation of Therapy Effectiveness

According to my practice at the Institute of Rheumatology, the patient went through six therapy sessions. Through each therapy, I have focused on the main problematic issues of the patient to reduce the pain and improve his recovery rate. At the beginning of his therapy sessions, the pain in his left ankle, right knee, and the swelling (edema) were the primary problems. By exercising and executing different treatment procedures, I could see the daily improvements in the patient.
And according to his history of participating in different sports and not getting enough recovery from those sports activities, he triggered some of the symptoms such as hypertonic, shortened muscles, and restriction in his skin, fascia, and joint play. However, his job (sitting behind the table during the working hours of the day) might be one of the triggers of his symptoms as well. By initiating different treatment procedures, I targeted the primary symptoms for the short-term therapy plan and by focusing the secondary symptoms such as the posture, the breathing pattern, and the movement stereotypes under my long-term goals.

The patient himself was also very motivated, Which was one of the reasons that the procedures appeared to be effective because the patient was following the instructions given by my supervisor and me during his short stay at the hospital.

By performing daily sessions using techniques such as PIR, I assume that I was able to reduce the tonesity of the hypertonic muscles and slightly increase the relaxation of those targeted muscles.

4. Final conclusion

The experience of working on my bachelor's thesis allowed me to gain an in-depth knowledge of rheumatologic diseases and deepened my interest in them. Furthermore, I have developed a deeper respect for patients, but I have also grown to appreciate the efforts of the healthcare professionals who help patients to recuperate and enable them to return to their normal lives as soon as possible. I have gained so many valuable experiences in the one month period in my practices at the Institute of Rheumatology that will be extremely useful in my future practices. I have seen numerous interesting cases and different diseases that wouldn't be possible without the opportunity of attending such a practice.

I have also learned numerous lessons and instructions from my supervisors throughout my practices in the hospital and through research of this thesis's theoretical part.
All of these allowed me to gain enough belief and wisdom to stand on solid feet in whatever path I will go in the future.

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6. Annex

6.1 Application for Ethics Board Review:

CHARLES UNIVERSITY
FACULTY OF PHYSICAL EDUCATION AND SPORT
José Martího 31, 162 52 Prague 6-Veleslavín

Responsibility for the protection of all research subjects lies on the researcher(s) and not on the research subjects themselves, even if they gave their consent to participation in the research. All participants of the research team must take into consideration ethical, legal and regulative norms and standards of research involving human subjects applicable not only in the Czech Republic but also internationally.

I confirm that this project description corresponds to the plan of the project and, in case of any change, especially of the methods used in the project, I will inform the UK FTVS Ethics Committee, which may require a re-submission of the application form.

In Prague, 14.01.2022 Applicant's signature:

Approval of UK FTVS Ethics Committee

The Committee: Chair: Doc. PhDr. Irena Parry Martínková, Ph.D.
Members: Prof. PhDr. Pavel Slepička, DrSc. Prof. MUDr. Jan Heller, CSc.
PhDr. Pavel Hráský, Ph.D. Mgr. Eva Prokešová, Ph.D.
Mgr. Tomáš Ruda, Ph.D. MUDr. Simona Majorová

The research project was approved by UK FTVS Ethics Committee under the registration number: 039/2022
Date of approval: 14.1.2022

UK FTVS Ethics Committee reviewed the submitted research project and **found no contradictions** with valid principles, regulations and international guidelines for carrying out research involving human subjects.

The applicant has met the necessary requirements for receiving approval of UK FTVS Ethics Committee.

UNIVERZITA KARLOVA
Fakulta tělesné výchovy a sportu
José Martího 31, 162 52, Praha 6
– 20 –
Stamp of UK FTVS

Signature of the Chair of
UK FTVS Ethics Committee

6.2 Patient's Consent form

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, Helsinskou deklarací, přijatou 18. Světovým zdravotnickým shromážděním v roce 1964 ve znění pozdějších změn (Fortaleza, Brazílie, 2013) a dalšími obecně závaznými právními předpisy Vás žádám o souhlas s prezentováním a uveřejněním v ý s l e d k ů v y š e t ř e n í a p r ů b ě h u t e r a p i e p r o v á d ě n é v r á m c i p r a x e na ……., kde Vás příslušně kvalifikovaná osoba seznámila s Vaším vyšetřením a následnou terapií. Výsledky Vašeho vyšetření a průběh Vaší terapie bude publikován v rámci bakalářské práce na UK FTVS, s názvem ……

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

Získané údaje, fotodokumentace, průběh a výsledky terapie budou uveřejněny v bakalářské práci v anonymizované podobě. Osobní data nebudou uvedena a budou uchována v anonymní podobě. V maximální možné míře zabezpečím, aby získaná data nebyla zneužita.

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

Jméno a příjmení osoby, která provedla poučení..... 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.

Místo, datum .....

Jméno a příjmení pacienta ..... Podpis pacienta: .....

Jméno a příjmení zákonného zástupce.....….

Vztah zákonného zástupce k pacientovi ..... Podpis: .....

6.3 List of tables