CHARLES UNIVERSITY

Faculty of Physical Education and Sport

BACHELOR THESIS

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CHARLES UNIVERSITY

FACULTY OF PHYSICAL EDUCATION AND SPORT

Physiotherapy Department

A Case Study of Physiotherapy on a Patient after Liver Transplantation

Bachelor Thesis

Thesis Supervisor: **Thesis Author:**

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Declaration

I hereby declare that this work is entirely my individual work, and I have listed all the sources and literature utilised throughout the thesis. Neither this work nor a substantial part of it has been submitted to another academic institution.

…….……

In Prague ……. Author's Signature

Acknowledgements

First and foremost, I would like to thank my family for their ongoing support and patience with me. Namely, my father, Wajjiya Priyantha Hettiaratchi, and my mother Hana Hettiaratchi Sklenarova. Furthermore, I am grateful for the assistance provided by my thesis supervisor Mgr. Ilona Kučerová. Primarily for expanding and improving my physiotherapeutic skills during clinical demonstrations with her throughout the course.

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Abstrakt

Název: Kazuistika fyzioterapie u pacienta po transplantaci jater

Autor: Lukas Hettiaratchi

Cíl:

Účelem této práce je přezkoumat do hloubky teorii týkající se transplantací jater spolu s rehabilitačním procesem, který s tím souvisí. Navíc vytváří adekvátní kazuistiku pacienta po transplantaci jater.

Metody

Tato bakalářská práce je rozdělena na dvě části, část teoretickou a část speciální. První část tvoří informace shromážděné prostřednictvím odborné literatury, zahrnuje anatomii, fyziologii a patofyziologii jater. Dále se ponoří do specifik transplantací jater a doporučené fyzioterapie. Druhá část představuje kompletní kazuistiku časné pooperační fyzioterapie u pacienta po transplantaci jater. Kazuistika byla provedena během měsíce klinické praxe v Institutu klinické a experimentální medicíny (IKEM) ve dnech 10.01.2022 – 04.02.2022.

Výsledky:

Pacientka po celou dobu fyzioterapeutické péče výrazně pokročila. Její celkový fyzický stav se zlepšil, což vedlo ke schopnosti samostatné vertikalizace a chůze.

Klíčová Slova:

Játra, transplantace, alkoholové onemocnění jater, portální hypertenze, ascites, fyzioterapie

Abstract

Title: A Case Study of Physiotherapy on a Patient after Liver Transplantation

Author: Lukas Hettiaratchi

Objectives:

The purpose of this work is to review in-depth theory concerning liver transplantations along with the rehabilitation process that entails it. Moreover, create an adequate case study of a patient after liver transplantation.

Methods:

This work is divided into two sections, the theoretical part, and the special part. The first part consists of information gathered through scientific literature; it includes the liver's anatomy, physiology and pathophysiology. Furthermore, it dives into the specifics of liver transplantations and recommended physiotherapy. The second section exhibits a complete case study of early post-operative physiotherapy on a patient after liver transplantation. The case study was conducted during a month of clinical practice at Institut Klinické a Experimentální Medicíny (IKEM) from the 10/01/2022 – 04/02/2022.

Results:

The patient significantly progressed throughout the physiotherapeutic care. Their overall physical condition improved, which led to the ability of independent verticalisation and gait.

Keywords:

Liver, transplantation, alcohol liver disease, portal hypertension, ascites, physiotherapy

TABLE OF CONTENTS

1 INTRODUCTION

The liver is the largest solid internal organ in the human body, weighing around 1.3kg. It is located in the upper right portion of the abdominal cavity, below the diaphragm. From filtering blood, to storing nutrients, to producing bile that digests fats, the liver is an essential organ to live (Centers for Disease Control and Prevention, 2015).

A liver transplant is performed in patients with advanced liver diseases, acute liver failure and/or live tumours. The IKEM Transplantation Surgery Department is the largest centre in Czech Republic where liver transplantations are performed. Their programme started in 1994; since then, over 1,300 transplantations have been performed. Presently, IKEM transplants over 120 livers yearly.

This bachelor thesis is divided into two parts: the general part and the special part. The former contains theory regarding the liver and liver transplantations. It will dive into the anatomy and physiology of the liver whilst describing specific liver diseases that lead to transplantations. Lastly, it will determine the physiotherapeutic process to prepare and rehabilitate a patient with liver transplantation.

The latter component of the bachelor thesis will consist of a case study on a patient after liver transplantation. The focus will be on evaluating and rehabilitating the patient in question. In the end, the initial and final examination will be compared to assess the effectiveness of the chosen physiotherapeutic methods. The case study occurred during a continuous month of clinical practice at IKEM in Prague. The primary goal of this work is to deepen my understanding of liver transplantation and employ physiotherapeutic skills accrued during three-year bachelor's course in physiotherapy at Charles University FTVS.

2 THEORETICAL PART

2.1 ANATOMY OF THE LIVER

The liver is a pinkish-brown peritoneal organ positioned under the diaphragm and runs across the right hypochondrium through the epigastric areas, and into the left hypochondrium. For orientation, the upper surface of the liver is percussed at the level of the fifth intercostal space. It takes the general shape of a prism with the base on the right and the apex to the left (Kapoor, 2017).

2.1.1 MACROSCOPIC STRUCTURE OF THE LIVER

The liver is encapsulated by a connective tissue capsule, and further reinforced by the peritoneum of the abdominal cavity. The peritoneum connects to the liver through four ligaments: the coronary ligament, the left and right triangular ligaments, and the falciform ligament (Taylor, 2022).

- The Coronary Ligament connects the central, superior aspect of the liver to the diaphragm.
- The Left and Right Triangular Ligaments respectively connect the superior ends of the liver to the diaphragm.
- The Falciform Ligament is sickle-shaped and runs across the anterior edge downward to the inferior border. It attaches the anterior surface of the liver to the ventral abdominal wall. It has a free edge that contains the teres ligament, a remnant of the umbilical vein.

The liver has two distinct surfaces: the diaphragmatic (anterior superior) and visceral (posterior inferior) surface. The former is smooth and convex as it fits comfortably under the diaphragm. The latter is moulded by the shape of surrounding organs, as it lies on the right kidney, right adrenal gland, right colic flexure, transverse colon, first part of the duodenum, gallbladder, oesophagus, and the stomach (May, 2014).

Anatomically, the liver comprises a large right lobe and smaller left lobe, separated by the falciform ligament. However, there are two additional ‘accessory’ lobes within the right lobe. Both of which are located on the visceral surface of liver. The caudate lobe originates from the

posterior side of the large right lobe and drapes the inferior vena cava (IVC). The quadrate lobe is inferior to the aforementioned lobe and originates from the visceral surface of the right lobe to wraps around the gallbladder (Gray, 2000). However, this division is not surgically significant.

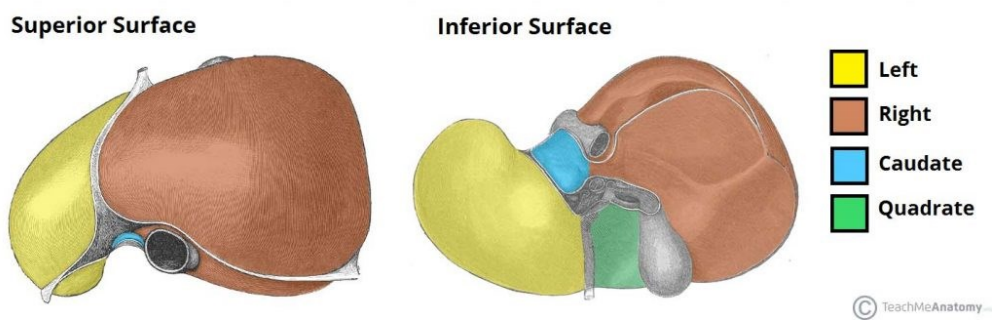

Figure 1: Anatomical Lobes of the Liver (May, 2014)

From a surgical perspective, the liver is separated into two roughly equal lobes by a fissure. This fissure is called the Cantlie's line, which runs from the gallbladder fossa to the IVC fossa. This separation is based on the right and left branches of the hepatic artery and portal vein with tributaries of hepatic ducts.

On that topic, the liver has an 'H-shaped' fissure on the visceral surface. The right vertical arm of the 'H' is shaped by the gallbladder inferiorly and IVC superiorly, however, it is interrupted by the caudate process. The contralateral vertical arm of the 'H' is formed by the teres ligament inferiorly and the venous ligament superiorly. Finally, the transverse arm of the 'H' is the contrived of the hilum, a five-centimetre fissure located in between the quadrate and caudate lobes (Kapoor, 2017).

2.1.2 MICROSCOPIC STRUCTURE OF THE LIVER

The liver consists of four major histological components and three functional units that work in unison to ensure the organ functions correctly. The histological components include hepatocytes (parenchymal cells), stroma, sinusoids, and spaces of Disse. And the three functional units are the classic lobules, portal lobules and liver acinus (Rad, 2017).

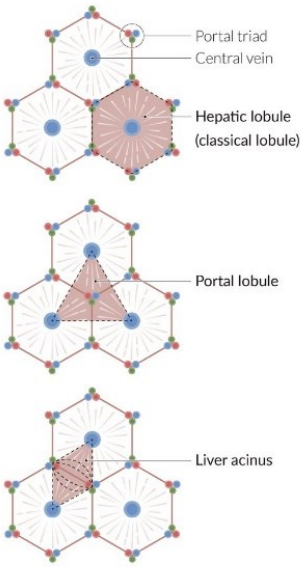

Figure 2: The Three Functional Units (Amboss, 2022)

Hepatocytes make up 80% of the cells of the liver, they are cuboidal epithelial cells that that perform most of the liver's functions. They commonly live up to five months. Each hepatocyte contains between two and four large, spherical nuclei in the centre. The small spaces between hepatocytes are called bile canaliculi (bile collection vessels), they are 1.0 – 2.0 µm in diameter (Rad, 2017). On the other side of hepatocyte cells, sinusoids (capillaries) run parallel to the bile canaliculi and drain into the bile ducts of the liver (Kapoor, 2017).

Stroma is a continuation of the capsule of Glisson, a layer of connective tissue surrounding the liver. The class of stroma is type III collagen (reticulin), which forms a network that provides integrity for the hepatocytes and sinusoids (Rad, 2017). Lastly, spaces of Disse are spaces in between hepatocytes and sinusoids.

The internal structure of the liver consists of up to 100,000 small hexagonal functional units called classic lobules. Their function is to diffuse oxygen and nutrients through their capillary walls into the liver cells. These units comprise a central vein encircled by six hepatic portal veins and six hepatic portal arteries which are connected through sinusoids (Taylor, 2022). These capillaries do not only run alone hepatocytes, as they also run down several Kupffer cells, which are macrophages that capture and break down old blood cells. At the boarder of these units are three structures that make up the portal triad (Taylor, 2022):

- Arteriole: a branch of the hepatic artery entering the liver.
- Venule: a branch of the hepatic portal vein entering the liver.
- Bile duct: a branch of the bile duct leaving the liver

The function of the portal lobule is exocrine, namely, bile secretion. This unit takes the shape of a triangle, with a central axis portal triad and the imaginary edges through three different portal canals. The area within the unit represents the hepatic region that secretes bile into the bile ducts (Krishna, 2013).

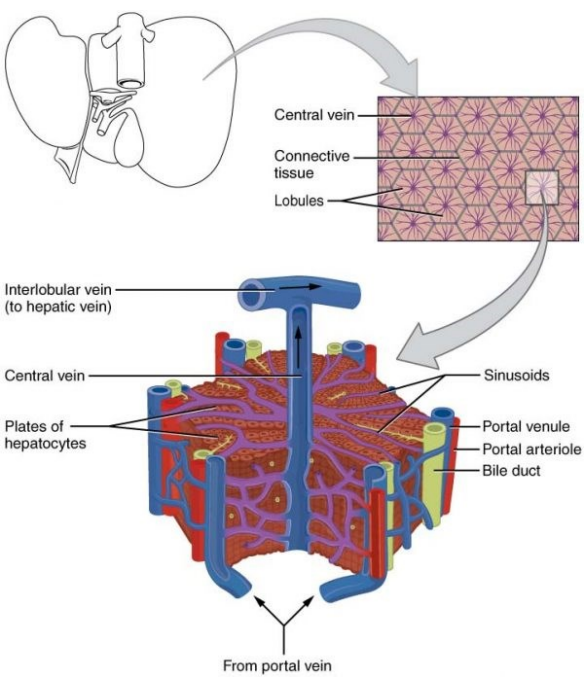

Figure 3: Labelled Classic Lobule Diagram (Taylor, 2022)

Lastly, the acinus unit focuses on perfusion and metabolism. This unit appears as a cone or oval. The short axis composed of a shared boarder between two adjacent classic lobules, and the long axis is an imaginary line between two neighbouring central veins (Krishna, 2013).

2.1.3 LIVER CIRCULATION

The liver receives around 25% of the cardiac output. It receives blood from two different sources: the hepatic artery and the portal vein. The hepatic artery is a branch of the coeliac trunk and supplies around 25% of blood to the liver. Whereas the portal vein is formed by the mesenteric and splenic veins, and it supplies around 75% of blood to the liver (Crumbie, 2014).

Both the hepatic artery and portal vein supply roughly 50% of the oxygen demand each. The hepatic artery carries oxygenated, nutrient poor blood, while the portal vein brings nutrient-rich, oxygen-poor blood to the liver (Elsaddig, 2021). The venous supply is carried from the gastrointestinal organs, including the colon, small intestine, large intestine, pancreas, stomach, and spleen. Sinusoids allow efficient transfer of nutrients and oxygen to the liver.

After the liver removes toxins and bacteria, approximately 50% of water-soluble nutrients are absorbed from the venous blood (Elsaddig, 2021). Correspondingly, blood accumulates in

the central veins within the classic lobules and drains into hepatic veins. From there, blood flows into the IVC and back to the heart (Lautt, 2009).

2.2 LIVER PHYSIOLOGY

The liver is an essential organ in the human body, it is thought that it has up to 500 separate vital functions in combination with other organs and systems. Some of these functions include supporting digestion, immunity, storage, proteins synthesis, amino acid metabolism, blood coagulation, detoxification, vitamin storage and more (Kalra et al., 2022).

The liver plays an active role during digestion through the production of bile: a mixture of water, bile salts, cholesterol, and the pigment bilirubin. Hepatocytes produce bile in the liver which is later stored in the gallbladder (Taylor, 2022). When fats reach the duodenum, the cells there release a hormone called cholecystokinin which stimulates the gallbladder to release bile. Bile travels through the bile ducts into the duodenum where the fats are emulsified, this process breaks down large clumps of fat into smaller once (Kalra et al., 2022). This increases the surface area of those fats and makes digestion easier.

The liver greatly contributes with protein metabolism. This process produces energy through gluconeogenesis. However, if there is an excess of protein, amino acids can be converted and stored as fat deposits (Institute for Quality and Efficiency in Health Care, 2009). Before ammino acids can be consumed that way, the nitrogen-containing group NH^2 must be removed. Thus, hepatocytes change NH^2 into ammonia NH^3. However, ammonia is toxic, so with the release of carbamoyl phosphate synthase (CPS), ornithine carbamoyltransferase (OCT), argininosuccinate synthase, argininosuccinate lyase, and arginase, the liver converts it into urea. Urea is then released into the blood, transported into the kidneys and then passed out of the body as urine (Rolfe, n.d.).

Furthermore, the liver supports the immune system through its Kupffer cells. As previously stated, Kupffer cells are a type of macrophages. They form part of the mononuclear phagocyte system along with macrophages in the spleen and lymph nodes. They capture digesting bacteria, decaying blood cells, parasites, cellular waste, and more (Taylor, 2022). While blood from digestive organs pass through the hepatic portal system, hepatocytes monitor contents of the blood and remove toxic substances before affecting the rest of the body. Enzymes withing

hepatocytes metabolize toxins such as alcohol and drugs into inactive metabolites, thus avoiding damage (Taylor, 2022).

Additionally, the liver acts as a storage space for essential nutrients vitamins, and minerals. attained through passing blood from the hepatic portal system. Some of these vitamins and minerals include:

- Vitamins: A, D, E, K, and B12
- Minerals: Iron and copper

When stimulated by insulin, glucose transported through hepatocytes get deposited as polysaccharide glycogen. The storage of the abovementioned nutrients in the liver helps manage the homeostasis of blood glucose (Kalra et al., 2022).

The liver is also an essential metabolic organ, primarily controlled by insulin along with other metabolic hormones. In glycolysis, glucose is converted into pyruvate, and this is consequently oxidized into the mitochondria to generate ATP in the Krebs cycle and phosphorylation (Canioni & Quistorff, 1994). Even during fasting, the liver can produce glucose, this is done through hepatic glucogenesis. This process is strictly regulated by hormonal and neural signals. The sympathetic system stimulates, and the parasympathetic system inhibits hepatic glycogenesis. For examples of hormonal signals: insulin stimulates glycolysis, lipogenesis supresses gluconeogenesis, and glucagon counteracts insulin (Rui, 2014).

2.3 LIVER PATHOPHYSIOLOGY

This chapter is centred around liver diseases that prompted a liver transplantation in the specific patient from the case study later in the report.

2.3.1 ALCOHOLIC LIVER DISEASE

As the name suggests, alcoholic liver diseases are liver injuries attributed to overconsumption of alcohol. Around two billion people consume alcohol around the world, and roughly seventy-five million of those are at risk of alcohol-associated liver disease (Asrani, Devarbhavi, Eaton, & Kamath, 2019). Heavy alcohol consumers commonly progress through three main types of liver diseases which rise in severity: alcoholic steatosis, alcoholic hepatitis,

and ethylic cirrhosis. Steatosis can develop after acute consumption of alcohol; however, hepatitis and cirrhosis are correlated with chronic alcohol abuse (Lieber, 2004).

A standard drink is defined by retaining about fourteen grams of pure alcohol. It is assumed that alcoholic liver diseases begin after a man has consumed four to five standard drinks or 80g of alcohol per day for approximately five years. Two to three standard drinks or 50g of alcohol per day commonly applies for women (Osna et al., 2017).

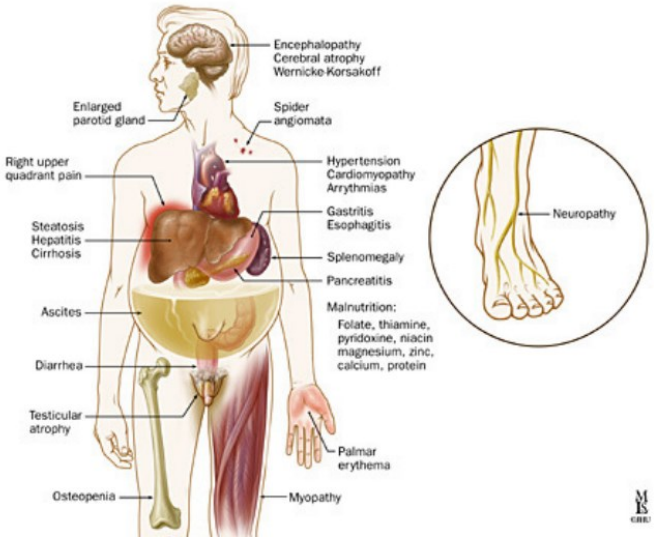

Figure 4: Alcoholic Liver Disease Symptoms (Johns Hopkins University, 2013)

Alcoholic liver diseases can cause a variety of clinical features, some patients remain asymptomatic, whereas some display portal hypertension, jaundice, ascites and more. Generally speaking, the more severe types of liver diseases generate more serious symptoms (Johns Hopkins University, 2013).

2.3.1.1 Alcoholic Steatosis

Alcoholic steatosis, otherwise known as fatty liver, can develop after a single session of heavy consumption. Meaning between four to five standard drinks within two hours. However, in most cases, steatosis does not render any symptoms. Steatosis is defined as the deposition of lipid droplets in hepatocyte cytoplasm. The term “fatty degeneration” is applied when > 5% of hepatocytes exhibit steatosis, whereas “fatty liver” is used when > 50% of hepatocytes display steatosis (Sakhuja, 2014). When fat reaches 5 - 10% of the liver’s weight it becomes concerning.

Steatosis can be microvascular and/or macrovascular. Frequently, lipid droplets in the cytoplasm of the hepatocytes (microvascular) expand and push the nucleus to the boundary of the cell (macrovascular). Moreover, macrovascular droplets have a low surface-area-to-volume ratio, meaning they are less prone to lipases (Sakhuja, 2014).

In about 90% of patients with alcoholic steatosis, liver enlargement is palpable. Nevertheless, it is a reversible lesion with a good prognosis if the patient ceases alcohol

consumption (Bastarrica, 2020). Patients who fail to stop drinking alcohol are prone to fibrotic liver disease as the presence of fat increases the risk of oxidative damage through peroxidation of the lipid droplets.

2.3.1.2 Alcoholic Hepatitis (Steatohepatitis)

In short, alcoholic hepatitis is inflammation (hepatomegaly) of the liver due to chronic excessive alcohol ingestion. It is an inflammatory liver injury characterized by hepatocyte ballooning degenerating, neutrophilic inflammation, apoptosis, and development of Mallory bodies (Osna et al., 2017). One-third of patients with alcoholic hepatitis remain asymptomatic, however, hospitalised patients generally present jaundice (causing icteric/yellow coloured skin), hepatomegaly, ascites, and fever (Johns Hopkins University, 2013).

Degenerative ballooning of hepatocytes is the primary process of cellular injury in alcoholic hepatitis. The cause is presumed to be membrane damage, as this allows an influx of fluid into the hepatocytes, thus, expanding or "ballooning" the cell (Lackner, 2011). Dilation of the endoplasmic reticulum, rearrangement of the intermediate filament cytoskeleton and accumulation of lipid droplets in the hepatocyte cytoplasm (through steatosis) are the leading causes for the damaging the membrane (Sakhuja, 2014).

Apoptosis is believes to be triggered by oxidative damage to the mitochondrial inner membrane. Lastly, Mallory bodies are inclusions within the cytoplasm in hepatocytes, their presence help diagnose steatohepatitis. They form as a result of damaged intermediate filaments in the hepatocytes (Stephens & Warren, 2010).

The prognosis of alcoholic hepatitis varies as it depends on the severity of the disease. If it is a mild case, the patient possesses a possibility of reversing damage. However, that is largely dependent on whether the patient concludes alcohol ingestion or not. In serious cases of steatohepatitis, damage is unreversible and the prognosis is slim (NHS, 2018).

2.3.1.3 Fibrosis: Alcoholic cirrhosis

Fibrosis is the process of replacing injured tissue with collagenous scar tissue. It results from the abnormal perpetuation of the healing process (fibrogenesis) due the continual introduction of lesions. Cirrhosis is the late stage of scarring/fibrosis. As more scar tissue forms, it makes liver functions more challenging, this is called decompensated cirrhosis (Schuppan & Afdhal, 2008).

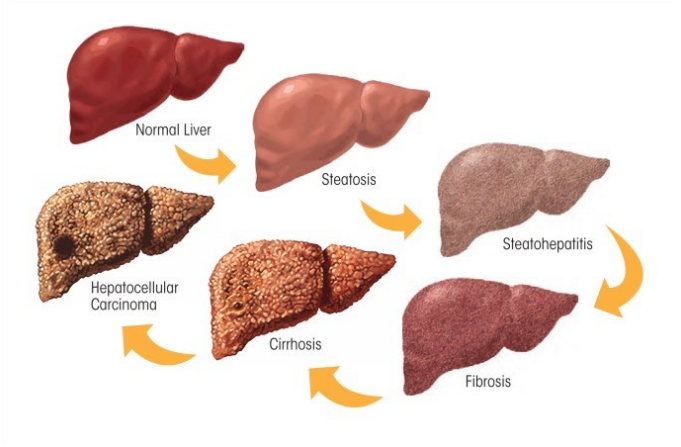

Figure 5: Types of Alcoholic Liver Diseases Increasing in Severity (Osna, Donohue, Jr., & Kharbanda, 2017)

Patients with severe alcoholic cirrhosis who do not stop consuming alcohol face a 50% chance of survival for more than five years (NHS, 2018). Common symptoms include hepatomegaly, spider angioma/veins, palmar erythema, testicular atrophy (in males), ascites, and jaundice (Johns Hopkins University, 2013). Severe alcoholic cirrhosis is not reversible.

Cirrhosis is always accompanied by distortion of the hepatic vasculature; this leads to shunting of the portal and atrial blood supply into the hepatic outflow. That impairs the exchange between sinusoids and neighbouring hepatocytes. Circulatory anomalies caused by cirrhosis include splanchnic vasodilation, vasoconstriction and hypoperfusion of kidneys, water and salt retention, and increased cardiac output. All these inherently exacerbates portal hypertension (Schuppan & Afdhal, 2008).

2.3.2 PORTAL HYPERTENSION

Portal hypertension is described as a pathological increase in portal venous pressure, largely caused by liver cirrhosis. As portal hypertension progresses, collateral vessels and arterial splanchnic vasodilation begin forming, this results in an increased blood flow into the portal circulation. If this continues, hyperdynamic circulatory syndrome develops, and that leads to further complications such as ascites and/or oesophageal or stomach varices (Iwakiri, 2014).

In addition to that, expanded plasma volume is always observed in portal hypertension. This occurs due to renal sodium retention, and it only provides another mechanism that

intensifies portal hypertension. Sodium restriction or spironolactone (a potassium-sparing diuretic) are frequently used solutions to reduce plasma volume expansion (Bosch et al., 1992).

Hyperdynamic syndrome caused by the vasodilation of arterial splanchnic vessels is a late complication of portal hypertension. It is characterized as a high cardiac output, increased heard rate, increased blood volume and a reduced overall systemic vascular resistance (Bolognesi et al., 2014).

Due to the increased resistance of blood flow to the liver, portal blood gets rerouted to the systematic circulation, varices form. The introduction of varices may obstruct hepatic veins, sinusoids, or portal veins. Crucially, the pressure of these abnormal vessels is high as well, increasing the risks of ruptures (Bolognesi et al., 2014).

2.3.3 ASCITES

Ascites is a pathological accumulation of peritoneal fluid; it is commonly observed in patients with decompensated cirrhosis. Around 60% of patients with cirrhosis display ascites within 10 years of the initial diagnosis. The two-year survival rate is 50% (European Association for the Study of the Liver, 2010). Doctors diagnose ascites when more than twenty-five millilitres of fluid collect within the peritoneum (Wint, 2021).

Cirrhotic ascitic fluid accumulates due to a variety of reasons, however the leading cause is portal hypertension. Ascites is correlated with several complications including spontaneous bacterial peritonitis (infection of abdominal fluid), hepato-hydrothorax (pleural effusion) and hepatorenal syndrome (impaired kidney function) (Moore & Thiel, 2013).

2.4 LIVER TRANSPLANTATION

The first liver transplantation in a human being took place in 1963 by Thomas Starzl (an American physician) et al. They performed five transplantations, of which none of the patients survived past twenty-three days. Two hundred liver transplants were performed globally by 1977, and during this period Strazl and Roy Calne (a British surgeon) continued to problem solve and pioneer liver the process. By 1989, Starzl et al reported up to 1,179 liver transplantations with revolutionary survival rates (Meirelles Júnior, et al., 2015):

In 1989, just 33 years ago, the 1-year and 5-year survival rates were 73% and 64%, respectively. Presently, the one-year survival rate after a liver transplant is 80 – 90%, and the five-year survival rate is 75% (Kim, et al., 2018).

Most liver transplants use the whole organ; however, segmental and reduced graft transplantations exist as well. Segmental (split) liver transplantations allow two recipients to obtain a portion of the liver (generally, to one adult and one child). While reduced graft transplantations are performed in cases of size mismatch between the doner and recipient (Achanta, 2021). There are two types of doner in liver transplantations: deceased and live.

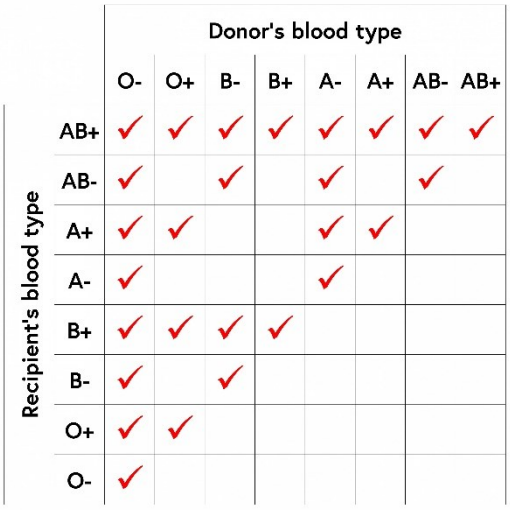

Figure 6: ABO Compatibility (Australian Academy of Science, 2018)

Matching doners and recipients for a liver is primarily based on ABO (blood type) compatibility and graft to recipient weight ratio (GRWR). The generally accepted threshold for the GRWR is 0.8% (Alim, Erdogan, Yuzer, Tokat, & Oezcelik, 2016). Human leukocyte antigens (HLA) based compatibility is not necessary for liver transplants (Achanta, 2021).

2.4.1 SURGICAL PROCEDURE

The two key stages of liver transplantations are organ retrieval and recipient implantation.

2.4.1.1 Donor Procedure

The first stage of a liver transplantation is the extraction of the organ from the doner. The method of retrieval differs according to the form of deceased donation. These include donation after brainstem death (DBD) and donation after circulatory death (DCD) (Achanta, 2021).

To retrieve the liver from a DBD doner, the abdomen and chest are fully exposed through a midline laparotomy and thoracotomy. Then the liver is mobilised (dissection of ligament attachments) and the common bile duct is cut along with the gallbladder (Achanta, 2021). The doner is heparinised (to prevent coagulation) and cold preservative fluid is introduced before the descending thoracic aorta is cross clamped. Next, the liver is swiftly removed with the

common hepatic artery and inferior vena cava intact. Lastly, the organ is placed on a back table with ice for further perfusion (Murphy, Bodenham, & Thompson, 2012).

In the case of a DCD doner, a quick laparotomy and thoracotomy is performed after asystole (flatline) is confirmed (Manara, Murphy, & O'Callaghan, 2012). The aorta is once again cross clamped with cold preservative fluid added to reduce the warm ischemia time. Finally, the remainder of the process is the same as a DBD doner. The liver is extracted, and portal perfusion is established through a portal vein cannula (Achanta, 2021).

2.4.1.2 Recipient Procedure

The second half of the transplantation is further divided into two sub-stages: the hepatectomy and the liver graft implantation. There are two types of hepatectomy: the classic approach and the piggyback technique (Achanta, 2021). In essence, the primary difference is that the former removes the recipient's inferior vena cave, and the latter preserves it.

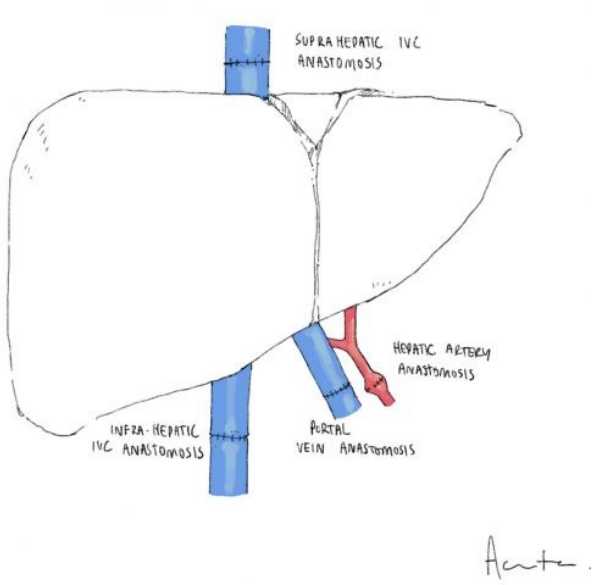

Figure 7: Classical Approach (Achanta, 2021)

The dissection of the inferior vena cava in the classic approach is known to cause an interruption of venous return, which causes significant hemodynamic changes. Namely, it has the potential to reduce blood pressure and flow to vital organs (Gurusamy, Pamecha, & Davidson, 2011). The piggyback technique provides the benefit of avoiding this, so when feasible, this type of transplantation is preferred.

Corresponding to the selected hepatectomy type, the procedure will carry on with a vena cava replacement transplant or piggyback implantation. Since the IVC is not dissected in a piggyback implantation, the doner IVC is attached to the recipient's one side to side, or the supra hepatic end is anastomosed (linked) to the recipient hepatic veins (Belghiti, Panis, Sauvanet, Gayet, & Fékété, 1992). However, in both forms of implantation, the portal veins and hepatic arteries of the doner and recipient are anastomosed end-to-end.

Anastomosis is a surgical connection between two structures. In a liver transplant, the preferred form is called biliary-enteric anastomosis as it reduces biliary leakage that may result in infection (Cafasso, 2018). All in all, the full procedure of a liver transplant may take between six to twelve hours. Following the procedure, an immunosuppressant drug called tacrolimus is used to limit immune system functions. This reduces the possibility of rejecting the graft (Perálvarez, De la Mata, & Burroughs, 2014).

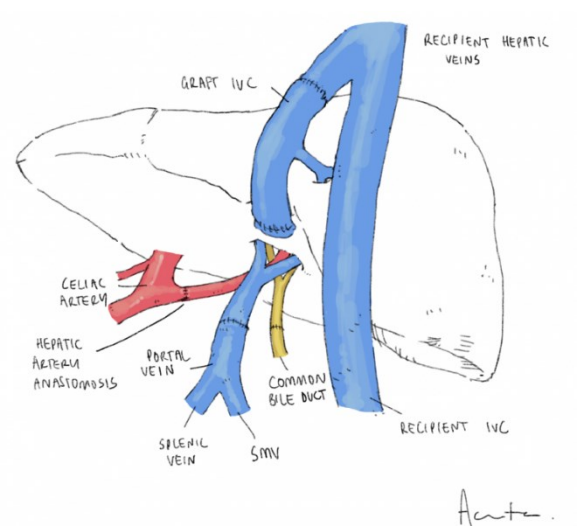

Figure 8: Piggyback Technique (Achanta, 2021)

2.4.2 INDICATIONS

Liver transplantation is the only definitive treatment option in cases of irreversible acute or chronic liver failure. Nevertheless, many factors are evaluated before a patient is put on the waiting list for a liver. The patient undergoes several tests to assess their health state and discover potential contraindications (Farkas, Hackl, & Schlitt, 2014).

These extensive evaluation includes general assessments, psychological tests, blood tests, microbiology/virology, screening for infections/tumours, surgery capability, radiologic and assessments. After all the results are compiled, a final assessment is conducted by the transplant board. This particular board usually consists of a hepatologist, transplant surgeon, transplant anaesthetist, and psychiatrist) (Farkas, Hackl, & Schlitt, 2014).

The most common indications of liver transplantations are end-stage liver disease due to chronic hepatitis C, alcoholic liver disease, or non-alcoholic fatty liver disease (Varma, Mehta, Kumaran, & Nundy, 2011). The following is a list of several other conditions indicated towards a liver transplantation (Achanta, 2021):

- Non-cholestatic liver disorders
    - Chronic HBV infection, autoimmune hepatitis, or cryptogenic
- Cholestatic liver disorders
    - Primary biliary cirrhosis (PBC) or Primary sclerosing cholangitis (PSC)

- Metabolic liver disorders
    - Wilson's disease, hereditary hemochromatosis, or Crigler–Najjar syndrome
- Primary malignancies of the liver
    - Hepatocellular carcinoma, hepatoblastoma, or hilar cholangiocarcinoma
- Budd-Chiari syndrome
- Drug-induced acute liver failure

2.4.3 CONTRAINDICATIONS

Contraindications can be divided into two categories: absolute and relative. If the patient exhibits any absolute contraindications, it dismisses them from getting a new liver. Whilst relative contraindications alert the transplantation board, entailing further tests and evaluations before a discission is made. The following presents a list of varies contraindications towards liver transplantation (Farkas, Hackl, & Schlitt, 2014).

- Absolute Contraindication
    - Active alcohol abuse
    - Uncontrolled systemic infections
    - Uncontrolled extrahepatic malignancy
    - Advanced cardiac or pulmonary disease
    - Uncontrolled/limiting medical conditions
- Relative Contraindications
    - Psychosocial conditions
    - Advanced age
    - Severe hepatopulmonary or severe hepatorenal syndrome
    - Severe obesity/malnutrition

To further elaborate on a certain contraindication, the United Network for Organ Sharing (UNOS) and EuroTransplant International Foundation (ET) require a patient to be abstinent from alcohol and drugs for a minimum of six months to be considered for the organ waiting list (Varma, Mehta, Kumaran, & Nundy, 2011).

2.4.4 POST OPERATIVE COMPLICATIONS

Early detection of post operative complications is imperative to the survival of both the graft and patient. Ultrasounds are routinely performed soon after the surgery to detect possible complications. These complications can be categorized as either vascular, biliary, parenchymal, and malignant (Caiado et al., 2007). Postoperative haemorrhage is the most common surgical complication (15%) (Achanta, 2021).

About twenty-five to fifty percent of liver transplant patients undergo acute graft rejection episodes within the first year after the procedure. Symptoms include abdominal pain, edema of lower extremities, dark urine colour. Treatment options include immunosuppression dose modifications or high dose intravenous corticosteroids, generally they are effective at halting these episodes (Roayaie & Feng, 2022).

The most common vascular complications include hepatic artery thrombosis, portal vein thrombosis, and venous outflow obstruction. Treatments for all three include interventional endovascular techniques, surgical revision, or re-transplantation. Specifically, for venous outflow obstruction, endovascular intervention with stenting is often utilized as treatment (Achanta, 2021).

Biliary complications include strictures, bile leakage, obstruction, and infection. They are usually identified through magnetic resonance cholangiopancreatography (Craig & Heller, 2021). Bile leakages frequently occur in the early postoperative period, and this may lead to localised peritonitis or sepsis (Achanta, 2021).

Long term complications include systemic hypertension, as ischaemic heart disease, diabetes mellitus, renal impairment, emergence of undetected donor diseases, and chronic graft rejection. Both diabetes mellitus and renal impairment is believed to occur due to long term calcineurin inhibitor (immunosuppressant) use (Achanta, 2021).

2.4.5 QUALITY OF LIFE

The ultimate goal of a liver transplant is to nullify adverse diseases and prolong a patient's life. Fortunately, as previously mentioned, the one-year survival rate after a liver transplant is 80 – 90%, and the five-year survival rate is 75% (Kim, et al., 2018). However, an improved of the patient's quality of life is a key objective and true indicator of a successful liver transplant.

Quality of life is “an overall sense of well-being, including aspects of happiness and satisfaction with life as a whole, which is measurable through mental wellbeing, physical functioning and overall health status” (Butt et al., 2012).

Physical health generally begins improving beyond the first month post transplantation, and it continues for up to two years after the surgery. Post operative complications are considered anomalies as it may impede the progression of physical health. However, lower overall physical activity was observed in patients post transplantation compared to the general population (Onghena, et al., 2016).

Significant improvements of depression and anxiety rates were reported throughout the first-year post-surgery in cases without complications. This may be explained through the patient’s relief of a second chance in life while heeding physical health progression (Chen et al., 2012).

2.5 PHYSIOTHERAPY AFTER LIVER TRANSPLANTATIONS

Physiotherapy in liver transplant patients is generally divided into three phases: pre-operative physiotherapy, early post-operative physiotherapy and late post-operative physiotherapy. It is important to clarify contraindications and indications towards both short- and long-term physiotherapy. Relative contraindications generally present as post operative complications. Acute graft rejection, acute haemorrhage, fever, electrolyte imbalance, physiological instability, and severe cardiovascular are several co-morbidities to keep an eye out for (Yıldırım & Yurdalan, 2012).

The primary goal of physiotherapy post-surgery is to improve the patient’s quality of life. This is achieved by increasing muscle strength, preventing excessive fatigue, enhancing aerobic capacity, and increasing physical activity levels. However, physiotherapy can be applied at any stage of the patient’s disease process in the absence of any blaring contraindications (Yıldırım & Yurdalan, 2012).

2.5.1 PREOPERATIVE PREPARATION

Patient’s that undergo physiotherapy prior to the surgery tend to emerge in better conditions. Their improved condition further helps patient’s overcome post-operative complications. These particular patient’s generally present decreased muscle mass and

strength, low bone mineral density, increased levels of fatigue and decreased aerobic capacity (Yıldırım & Yurdalan, 2012).

Two thirds of cirrhotic patient's display significantly reduced aerobic capacity; this increases the chances of postoperative pulmonary complications (PPCs). However, a study showed that the incidence of PPCs within 14 postoperative hospital days halved in patients who received preoperative physiotherapy compared to those who did not (Boden, et al., Preoperative physiotherapy for the prevention of respiratory complications after upper abdominal surgery: pragmatic, double blinded, multicentre randomised controlled trial, 2018).

Preoperative physiotherapeutic objectives generally attempt to combat the above-mentioned symptoms. This includes increasing muscle strength, endurance, and aerobic capacity in order to enhance the patient's general condition and for the lack of a better word, "durability" for the operation (Yıldırım & Yurdalan, 2012).

2.5.2 EARLY POST-OPERATIVE CARE

The most common physiotherapeutic methods used in the early postoperative stage are respiratory therapy (vibrations, assisted coughing), positioning, mobilization, verticalization and gait. The main intention is to restore functional independency and avoid acute postoperative complications such as immobilization, and pulmonary complications (Stiller, 2000).

Bed rest is commonly prescribed after the patient moves to the intensive care unit (ICU), this is primarily due to drainage tubes, arterial lines, and urinary and nasogastric catheters (Wade, 2016). That is why mobilization is essential as it prevents immobilization complications such as muscle atrophy and pressure ulcers. However, mobilization should be implemented gradually to avoid aggravating pain or other problems. Passive motion avoids reduction of range of motion (ROM) and active movements stimulate circulation and respiration (Yıldırım & Yurdalan, 2012).

Unsurprisingly, pain is common amongst recent graft recipients, especially with the size of a liver graft. Therefore, analgesic treatments are an important aspect of day-to-day therapy in the acute stage. This can vary between soft tissue techniques to respiratory therapy to ease any discomfort (Stiller, 2000).

2.5.3 LATE POST-OPERATIVE CARE

Late post operative care can further be divided into two subphases: early and late. The early phase involves the first three months since the patient was discharged from the hospital. The late stage begins after the initial three months (Yıldırım & Yurdalan, 2012).

The earlier stage includes of educating the patient as home exercise programs are generally prescribed. The goals of the home exercises are to reach a minimum amount of physical activity per day. This accelerates the progression towards physical health and self-dependence. More importantly, as per preoperative and early postoperative care, this also helps prevent complications (Sullivan et al., 2016).

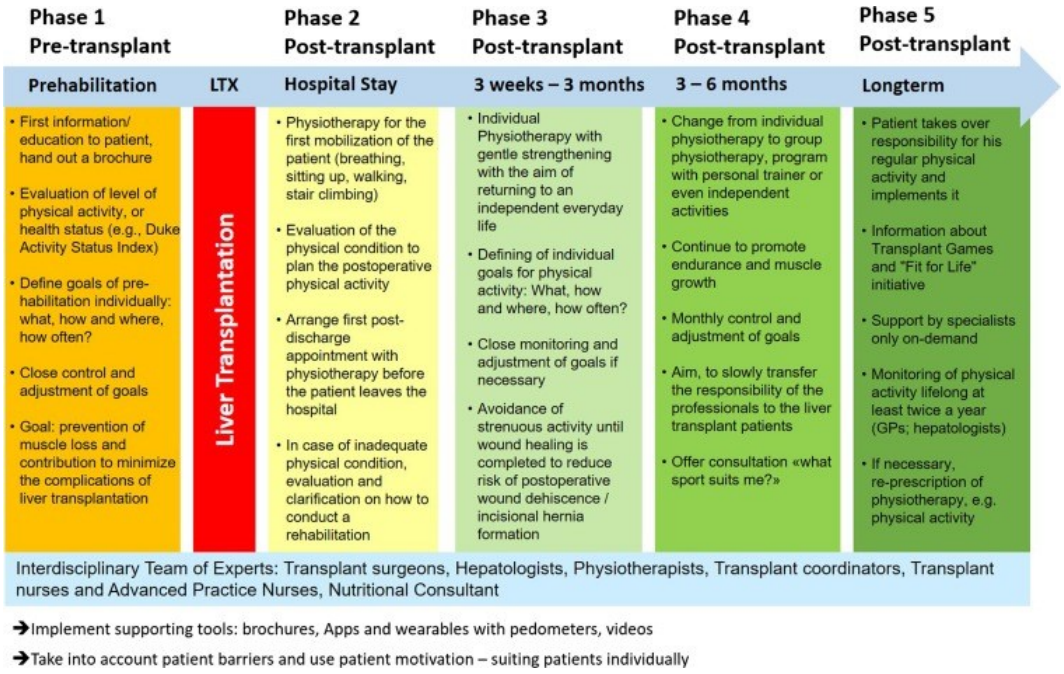

Figure 9: A Planned Physical Activity Program for a Liver Transplant Patient (Beekman, Berzigotti, & Banz, 2018)

The objective of the later stage of late-operative care primarily revolves around maximising the patient's independence, hence, improving the patient's quality of life. Therapy focuses on reintroducing the patient to leisure activities, social activities and/or sports if the patient chooses so. Resistance exercises are common during this period to restore muscle strength and prevent osteoporosis. Whereas aerobic training such as walking, jogging and cycling reduce onsets of cardiopulmonary complications and reduce fatigue. (Yıldırım & Yurdalan, 2012).

2.6 EVIDENCE BASED MEDICINE ANALYSIS

Evidence based medicine is a systemic approach which allows health care professionals to use scientific evidence (supplied through clinical studies) to help make decisions in their work. The following will provide a summary and evaluation of some clinical studies regarding liver transplants and physiotherapy.

The first clinical study describes that their objective was "To assess the efficacy of a single preoperative physiotherapy session to reduce postoperative pulmonary complications (PPCs) after upper abdominal surgery" (Boden et al., 2018). The study was performed in multidisciplinary preadmission clinics at three tertiary public hospitals in Australia and New Zealand.

In total, 441 participants over the age of eighteen who were within six weeks of their major upper abdominal surgery engaged. The participants were randomly assigned to one of two groups. The first group received an informational booklet, while the second group attained a thirty-minute respiratory physiotherapy session. They were then monitored for twelve months intermittently. By the end, 432 completed the trial (Boden et al., 2018).

The study measured the frequency of postoperative pulmonary complications, such as hospital acquired pneumonia after fourteen postoperative days. This variable was measured through the Melbourne group score which is a routine respiratory assessment. The outcome was that the prevalence of postoperative pulmonary complications after fourteen hospital days in the second group halved. This implies that respiratory therapy manages to prevent postoperative pulmonary complications 50% of the time (Boden et al., 2018). However, more studies must be conducted to evaluate the further understand the effectiveness of respiratory therapy.

Another study analysed the "acceptability of a 12-week program of adapted physical activity (APA) and its impact on aerobic capacity, muscle strength, and quality of life before liver transplantation (Debette-Gratien et al., 2015). Thirteen participants were included, however only eight completed the trial before their transplantation.

The results present an increase in mean VO2 peak values from 21.5 ± 5.9 mL/kg per min to 23.2 ± 5.9 mL/kg per min after 12 weeks of training. The remaining results were presented

as p-values (measuring statistical significance). An outcome of 0.05 is considered statistically significant, and then the lower this value is, the more feasible and reliable the results are. The six-minute walking distance test P: 0.02, the strength testing of knee extensor muscles: P: 0.008 and the ventilatory threshold power P: 0.02 all presented statistically significant results (Debette-Gratien et al., 2015).

The conclusion of this study was that a program of adapted physical activity is reliable, effective and safe for patients awaiting a liver transplantation. Nevertheless, more studies are required to evaluate the postoperative results of programs of APA.

Lastly, the third clinical study depicted their aim was to "evaluate the effects of a respiratory physiotherapeutic program on liver transplantation candidates" (Limongi et al., 2014). Respiratory muscle strength, surface electromyography of the rectus abdominis and diaphragm, and spirometry was tested on forty-two participants (liver transplantation candidates) after three months of respiratory therapy.

Twelve patients were randomly assigned to the control group and five to the intervention group. The intervention group participants received an explanatory manuals which consisted of "diaphragmatic breathing exercises, diaphragmatic isometric exercise, threshold inspiratory muscle training (IMT), lifting the upper limbs with a bat, and strengthening the abdominals" (Limongi et al., 2014). The control group did not take part in any additional therapy program.

Significant statistical differences were noted between the initial and final initial forced expiratory flow as the percentage raised from 25% to 75%. The conclusion is that the intervention group benefitted from the therapy program (Limongi et al., 2014). However, the number of participants in this study was relatively low, suggesting the viability of it is minimal. Nevertheless, the promising results does encourage further analysis of the effects of respiratory therapy pre and post liver transplantation.

3 SPECIAL PART

3.1 METHODOLOGY

The special part of this bachelor thesis was based upon a month of continual clinical practice at Institut Klinické a Experimentální Medicíny (IKEM). This practice took place from the 10/01/2022 – 04/02/2022 whilst under supervision of Bc. Robert Charvát and Mgr. Daniela Sárazová in the Department of Anaesthesiology, Resuscitation, and Intensive Care, the Department of Hepato-gastroenterology (in the ICU) and lastly the Inpatient Department (IPD). The patient at hand was after a liver transplant due to liver cirrhosis. Prior to the commencement of examination and therapy, the patient was informed about the project and willingly signed the consent form (Annex 2), which was approved by the Ethics Committee of Charles University under the registration number 105/2022 (Annex 1).

The patient was hospitalized in IKEM under the Department of Anaesthesiology and Resuscitation Care, they underwent two therapies a day. The morning session was performed by me under the supervision of my supervisors, and the afternoon session was performed by the supervisors alone. The initial and final examinations were conducted at the beginning of the first and last sessions, respectively. Following the initial examination, a therapy plan was contrived including short-and long-term goals.

The physiotherapeutic methods used throughout the therapy sessions were the subjects of a three-year bachelor's course in physiotherapy at Charles University FTVS. The therapeutic methods and examinations utilized throughout the therapy included: respiratory therapy, repositioning, verticalization, VTE prevention, PNF according to Kabat, soft tissue techniques and PIR according to Lewit, and foam balling according to Jebavá. The apparatus included: one goniometer, one measuring tape, one neurological hammer and one foam ball.

3.2 ANAMNESIS

Patient: A. Z., female, 1958

Diagnosis: Ethyl liver cirrhosis - liver transplantation (19.1. 2022)

Chief complaint/problem (21/01/2022):

- Patient felt sharp abdominal pain around the scar.
- She said it was 7/10 on the pain scale.
- The pain was aggravated when she tried to rearrange her position in bed. Especially when lifting her head. It restricted her from moving in bed.
- While relaxed, the pain was a 4/10.

Personal anamnesis (PA):

- Portal hypertension, anamnestic ascites, state after spontaneous bacterial peritonitis
- State after appendectomy 1978
- Goiter caused by hypothyroidism on substitution treatment
- Idiopathic thrombocytopenic purpura, on treatment with thrombopoietin analogue
- State after partial laryngectomy for vallecular cancer-2016
- State after cervical radiotherapy for metastasis 6/2016
- State after the transitional introduction percutaneous endoscopic gastrostomy 6/2017
- State after cholecystectemia 2005
- State after excision for squamous cell carcinoma of the oral cavity 2007- piece under tongue, histologically carcinoma in situ state
- After left patella fracture (without osteosynthesis)
- Serious osteoporosis of the forearm, femoral necks, and lumbar spine
- 2/2021 a protocol examination was performed before liver transplantation. immune thrombocytopenia was not according to nursing hematologist contraindication for transplantation (prof. kozak FNKV)
- 3/2021 she had dental rehabilitation while being hospitalized in KH (hospital Kutna Hora), added ORL examination and heart MR (magnetic resonance) with finding lipoma. It was not considered as a contraindication for transplantation.
- 4/2021 placed to waiting list

Current Illness:

- Patient with liver cirrhosis toxonutritive etiology, with portal hypertension, after encephalopathy attack, after episode she had spontaneous bacterial peritonitis, with idiopathic thrombocytopenic purpura for thrombopoietin analog therapy, placed into waiting list for liver transplantation, accepted for immediate preparation for transplantation. Transplantation completed on 19/01/2022.

Pharmacological Anamnesis:

- Letrox 100 mcg tbl p.o. 1-0-0 Monday, Wednesday, Fridy, Sunday. Letrox 50 mcg tbl p.o. 1-0-0 Tuesday, Thursday, Saturday. Prednison 5 mg tbl p.o. 1-0-0. Magnosolv 365 mg por p.o. 2-0-2. Furon 40 mg tbl p.o. 1-1-0. Verospiron 50 mg cps p.o. 1-1-0. Kalnormin 1 g tbl p.o.p.o.p.o. 1-0-1. Acidum Folicum 10 mg tbl p.o.p.o.p.o.p.o. 0-1-0. Controloc 40 mg tbl p.o. 1-0-0. Kanavit 20 mg/ml por p.o. 5gtt-5gtt-5gtt. Lactulosa 667 mg/ml sir p.o.p.o. 1odm-1odm-1odm. Maltofer 100 mg tbl p.o. 1-0-1. Lyrica 150 mg cps p.o. 1-0-1,5. Vigantol 0,5 mg/ml por p.o. 15gtt-0-0 Monday. Calcichew D3 500 mg/200iu tbl p.o. 1-1-1. Nolicin 400 mg tbl p.o. 1-0-0. Nplate 250mcg sdr. for 14 days.

Family Anamnesis (FA):

- Mother died at 77 for liver cancer
- Father died at 77 for heart disease
- Brother died at 71 for pancreas cancer
- Daughter born 1992, after operation of heart after atrium disfunction
- Son, born 1989, has psoriasis

Occupational/Social Anamnesis (OA):

- She is retired, but she previously worked as a tailor. She now lives on a pension.
- She lives with her ex-husband in a house with one flight of stairs.

Hepatological Anamnesis (HA):

- Liver disease known since 1997, blaming by alcoholic hepatopathy, abstinent till 2010, after 2010 abuses continues till 2019, when for the first-time development of ascites with the need for puncture.
- 7/2020 hospitalized in IKEM to implement Transjugular intrahepatic portosystemic junction, which was contraindication for development of Idiopathic thrombocytopenic purpura at that time, treated by corticoids, without effect, then by thrombopoietin analogue; during hospitalization it grew to progress of hepatic encephalopathy, to bleeding from serious portal gastropathy; endosonography was done for suspected gastric lymphoma, without finding lesion.

Gynaecology Anamnesis (GA):

- Two times childbirth with Caesarean delivery (C-section)
- One spontaneous abortion
- Menopause started in 2006

Epidemiological Anamnesis (EA):

- Patient received three doses of the vaccination against SARS-CoV-2 (last one received 29.11. 2021).

Past Rehabilitation Anamnesis:

- The patient underwent rehabilitation after previous surgeries.

Addictions Anamnesis:

- Ex-smoker and drinker, used to drink up to three beers a day. However, she has been abstinent since 2019.

Allergies Anamnesis:

- Camomile (causes skin edema)

Excerpt from patient's health care file:

- Course of operation: Patient was under general anaesthesia. An incision under the right ribs was performed to access the abdominal cavity. There was no presence of ascites. Other than cirrhosis, there was no other pathology. Then the liver was mobilized from the surrounding tissues and the structures of the hilum were cut. This interrupted the hepatic artery and common bile duct in the hilus. The inferior vena cava was disconnected from the liver, thus interrupting flow of the portal vein. The hepatic veins were sewed up together with Prolene. Then a hepatectomy was performed followed by the implantation of the liver graft back into abdominal cavity. A piggyback implantation was performed, meaning the IVC was sewed side to side to the recipient's IVC. The portal vein was sewed end to end. Following that, the clamps were released, and the graft was perfused. Reperfusion was fast and homogenous. The liver graft displayed a nice (healthy) colour and consistency. The bleeding was then stopped. After that the hepatic artery was sewed end to end and the gastroduodenal artery was reconnected as well. The hilum presented good pulsations. The common bile duct was freely probed, and papilla sewing was performed approx. 9 mm CHCHA (choledocho-choledochus anastomosis) end to end without a stent. A tru-cut liver biopsy was taken, following there was a 20 min haemostatic pause. Subsequently, the abdominal cavity was rinsed and three penrose drains were placed. Lastly, after the bleeding got under control, the surgical wounds were sutured in layers.
- Recommendation - ultrasound after arrival

Physiotherapy Indications

After the liver transplant, the patient was indicated for bed ridden conditioning therapy, respiratory therapy and gradual verticalization according to the evolution of their health status. Other goals indicated for this patient was to teach them to care for their scar, help them activate their deep stabilization system due to the localization of the surgery and rehabilitate their independence.

Differential according to the Main Diagnosis

In a patient after a liver transplant, the scar in the upper right portion of the abdomen caused by the operation can be expected to cause abdominal and chest pain. The

aforementioned scar may additionally lead to restricted surrounding soft tissue and altered breathing stereotypes. The tracheostomy may only impair the patient's breathing stereotype more, and further upset the patient's return to their ADL. The patient may very well develop phlegm in the lungs, especially due to their continual supine position.

Due to prolonged periods of immobilization, the patient could also possibly suffer from thromboembolic diseases, congestion, pressure ulcers, shortening of tendons, and muscle contractures, and muscle weakness. All these complications may worsen the progression towards regaining self-dependence and the patient's previous ADL.

3.3 INITIAL KINESIOLOGICAL EXAMINATION

The examination was performed on 21/01/2022.

Present Status:

Subjective: Patient was not able to communicate verbally due to tracheostomy, therefore, she answered yes and no questions via nodding and shaking her head. She indicated of having a painful abdominal region with a pain rating of 7/10. She also felt weak, tired, and struggled to breath at times.

Objective: Patient was located in the Department of Anaesthesiology, Resuscitation, and Intensive Care, she was two days post operation. She had a tracheostomy, a permanent urinary catheter, a surgical drain, a peripheral arterial catheter (arterial catheter for invasive blood pressure monitoring), and a central venous catheter. Patient was also connected to a ventilator through the tracheostomy, the ventilator setting was set to SPONT. She wore glasses when reading the consent form and signed it without any issues. Patient followed conversations well and seemed oriented in time, space, and self.

- Height: 158cm
- Weight: 58kg
- BMI, BSA, somatotype: 23.2, 1.60m^2, Endomorph
- Heart rate: 80 beats/min
- Blood Pressure: 115/60
- Respiratory rate: 18 breaths/min
- Oxygen Saturation (SpO2): 97%

Static Postural Examination

This examination is generally demonstrated in standing position, however, due to the patient's condition, this was not possible. In that sense, the static segmental examination was performed in the bed in supine position without any pillows or other anti-decubitus instruments.

- The patient had mildly icteric coloured skin.
- Skeletal muscles appear to be hypotonic and hypotrophic.
- The head is in the correct axis of the spine.
- The face appears symmetrical.
- Upper Extremity:
    - All IP and MCP joints in semiflexion
    - Wrists in neutral position, resting on the bed.
    - Elbows supinated, clearly not fully extended.
    - Shoulders pronated. Right shoulder appears about one centimetre lower.
    - Calluses under the elbows bilaterally.
- Lower Extremity:
    - Right ASIS higher than the contralateral side (confirmed by palpation).
    - Pelvis appears to be in the neutral position in the frontal plane (confirmed by palpation).
    - Hips externally rotated around 15° bilaterally.
    - Knees not fully extended, around 10° flexion.
    - Symmetrical patellae bilaterally.
    - Ankles joints in mild semiflexion bilaterally.
    - Hallux valgus first MTP joints bilaterally.
    - Calluses under the heels bilaterally.
- Abdomen was convex, the umbilicus was shifted to the right by half a centimetre.
- Scar covered under sterile bandage; it appeared to be around 15cm long, it is located on the upper right part of the abdomen.

Assessment of Breathing Stereotype:

This examination is generally demonstrated in multiple positions, however, due to the patient's condition, this was not possible. In that sense, the assessment of breathing stereotype was performed in the bed in supine position without any pillows or other anti-decubitus

instruments. Patient was breathing through the tracheostomy and was connected to the Ventilator with the SPONT setting, meaning the patient initiated and sustained breathing themselves.

Through aspection, palpation and listening, it became clear the patient primarily used the upper thoracic region for respiration. The breathing wave began in the lower thoracic region during the inhalation and gradually moved cranially, ventrally to the upper thoracic region at the end of inhalation. Exhalation also primarily occurred in the upper thoracic region as it moved caudally to the lower thoracic region. Throughout the whole breathing wave, the abdominal region was not palpable nor seen.

Breathing was shallow but primarily felt in the upper thoracic region. It was not symmetrical as the left side was more prevalent during palpation. The breathing frequency was 18 breaths/min, and the intensity was about 1cm (how much thorax moved ventrodorsally).

Crackles were heard and felt during inhalation and primarily during exhalation. This was most likely due to a phlegm build up in the lungs.

Examination of Reflex Changes according to Lewit

I assessed the skin, subcutaneous tissue, and fascia of the chest, lower and upper limbs. I further investigated the muscle tone of the lower and upper limbs. I avoided the examining the abdominal region to avoid affecting the scar, the surgical drain, and causing pain to the patient.

The skin, subcutaneous tissue and fascia in the chest was restricted in all directions. They did not reach their physiological barriers, and all retained hard end feels. Both the upper and lower extremities revealed unrestricted skin, subcutaneous tissue, and fascia. The only anomaly was the forearm of the right UE, which exhibited restricted subcutaneous tissue and fascia. This may be due the peripheral arterial catheter. Regarding muscle tonus, the upper and lower extremities felt physiological. However, both rectus femoris felt hypertonic (primarily the right side).

Body Region		State of Fascia
Scalp		Normal
Neck		Normal
Chest		Restricted in all directions
Abdomen		Not Tested
Back		Not Tested
Limbs	UE	Tense in region of peripheral arterial catheter.
	LE	Normal

Table 1: Reflex Changes according to Lewit - Fascia

Anthropometric Examination by Haladová

UPPER EXTREMITY	Left Extremity	Right Extremity
Length (cm)		
Whole Arm	67	67
Humerus	30	30
Forearm	37	37
Hand	19	19
Circumference (cm)		
Upper Arm Relaxed	31	32
Upper Arm Flexed	32	33
Elbow	29	29
Forearm	27	27
Wrist	17	17
Metacarpal Head	23	23

Table 2: Anthropometric Lengths and Circumferences of UE

LOWER EXTREMITY	Left Extremity	Right Extremity
Length (cm)		
Anatomical	81	81
Functional	90	90
Thigh	45	45
Lower-Leg	35.5	35.5
Foot	24	24
Circumference (cm)		
Rectus	47	47
Vastus	45	45
Knee	38	37
Calf	31	31
Ankle	23	23
Heel	31	31
Metacarpal Head	23	23

Table 3 - Anthropometric Lengths and Circumferences of LE

Goniometric Examination by Janda

Due to the condition of the patient, all goniometry examinations were performed in supine position. This restricted the examination so not all planes were evaluated.

Joint	Plane	Left Extremity	Right Extremity
Shoulder	S	X – 0 - 180	X – 0 – 170
	F	160 – 0 – 0	150 – 0 – 0
	T	X – 0 – 70	X - 0 – 70
	R	70 – 0 – 50	60 – 0 – 40
Elbow	S	0 – 0 – 160	0 – 0 – 140
Radio - Ulnar	R	75 – 0 – 70	60 – 0 – 60
Wrist	S	70 – 0 – 80	70 – 0 – 80
	F	15 – 0 – 15	15 – 0 – 15

Table 4: Passive Goniometry of UE

Joint	Plane	Left Extremity	Right Extremity
Hip	S	X – 0 – 110	X – 0 – 100
	F	40 – 0 – 10	40 – 0 – 10
	R	Not Examined	Not Examined
Knee	S	0 – 0 – 125	0 – 0 – 120
Ankle	S	20 – 0 – 30	20 – 0 – 30
	R	10 – 0 – 10	10 – 0 – 10

Table 5: Passive Goniometry of LE

On several occasions the right side caused more pain as she felt her scar stretch during the examination movements. Therefore, it limited the assessment as the end barrier was not reached in the painful instances. Furthermore, the peripheral arterial catheter artificially restricted the right radio – ulnar joint as there was concern of disconnecting it. The central venous catheter reduced shoulder flexion and rotation as well due to patient discomfort.

Muscle Strength Examination by Janda

Due to the condition of the patient, all examinations were performed in supine. Therefore, some muscle strength tests were modified.

Joint	Movement	Muscles Involved	Left Extremity	Right Extremity
Shoulder	Flexion	Coracobrachialis Deltoideus (Clavicular part)	3	3
	Extension	Deltoids (Scapular part) Teres Major Latissimus Dorsi	Not Examined	Not Examined
	Abduction	Deltoideus (Acromial part) Supraspinatus	4 -	4 -
	Horizontal Adduction	Pectorals major	4 -	4 -
	External Rotation	Posterior deltoid Infraspinatus Teres minor	4 -	4 -
	Internal Rotation	Anterior deltoid Teres major Pectoralis major Subscapularis	4 -	4 -
Elbow	Flexion	Biceps Brachii Brachialis Brachioradialis	4	4
	Extension	Triceps brachii Anconaeus	4 -	4 -
Wrist	Dorsi Flexion	Extensor Carpi Ulnaris Extensor carpi radialis longus and brevis	4	4
	Palmar Flexion	Flexor Carpi Ulnaris Flexor Carpi Radialis	4	4

Table 6: Muscle Strength Test of UE

Joint	Movement	Muscles Involved	Left Extremity	Right Extremity
Hip	Flexion	Iliopsoas	4 -	4 -
	Extension	Gluteus Maximus Ischiocrural Muscles	Not Examined	Not Examined
	Abduction	Gluteus Medius/Minimus TFL	4 -	4 -
	Adduction	Adductor Magnus, Longus/Brevis Gracilis Pectineus	4 -	4 -
Knee	Flexion	Biceps Femoris Semitendinosus Semimembranosus	3	3
	Extension	Quadriceps Femoris	X	X
Ankle	Supination with dorsal flexion	Tibialis Anterior	3	3
	Palmar Flexion	Triceps Surae	3	3
	Supination with palmar flexion	Tibialis Posterior	3+	3+
	Plantar pronation	Peroneus Brevis/Longus	3+	3+

Table 7: Muscle Strength Test of LE

Muscle Length Examination by Janda

Muscle Group	Left Extremity	Right Extremity
M. Soleus	1	1
M. Gastrocnemius	2	2
Knee Flexors	1	1
Knee Extensors	Not Examined	Not Examined
Long Adductors	1	1
Short Adductors	1	1

Table 8: Muscle Length Test of LE

Both the muscle strength and length tests were orientational, so there was no need to assess every muscle. Moreover, due to the condition of the patient, only examinations performed in supine were possible. For the length tests specifically, only the lower extremity muscles were assessed as it could arise challenges during the rehabilitation process, especially with verticalization and gait.

Neurological Examinations

- **Cranial Nerve Tests:**
    i. Olfactory nerve: The patient effectively identified different smells such as coffee with their eyes closed.
    ii. Optic nerve: The patient successfully named distinct colours and was able to read (with glasses).
    iii. Oculomotor nerve: When a flashlight was shined at the patient's eyes, both pupils reacted simultaneously, and the patient was able to do cross pattern movements (look up and down, and side to side).
    iv. Trochlear nerve: The patient said she did not have double vision and there was no sign of significant head tilt.
    v. Trigeminal nerve: After running the therapist's hands on the patient's face (from the lateral edges of the forehead to the cheeks), the patient said it felt the same bilaterally so there was no reason for concern.
    vi. Abducens nerve: The same test as the oculomotor test was conducted and once again the result was negative, the patient had no limitation with his eye movements.
    vii. Facial nerve: The patient was asked to perform three facial expressions: smiling, raising his eyebrows, and blowing up his cheeks. He accomplished all three movements without any difficulties.
    viii. Vestibulocochlear nerve: During the whole therapy session, the patient had no trouble hearing and communicating. She also displayed good spatial awareness relative to her body.
    ix. Glossopharyngeal nerve: The patient was asked to swallow and then make an "ah" sound. She did this without any problem.
    x. Vagus nerve: This test was the same as the previous one, and the result was negative again.

xi. Accessory nerve: Patient displayed symmetrical movements when asked to shrug and look left and right.

xii. Hypoglossal nerve: This nerve was not examined properly as she was not able to speak clearly with the ventilator connected to her tracheostomy. However, she agreed that she did not stutter, and she had no issues with speech.

All the cranial nerves produced negative tests, implying there were no pathologies.

- **Deep Tendon Examination:**

Reflex	Left Extremity	Right Extremity
Biceps	Normal	Normal
Triceps	Normal	Normal
Brachioradialis	Normal	Normal

Table 9: Deep Tendon Reflexes of UE

Reflex	Left Extremity	Right Extremity
Patellar	Normal	Normal
Achilles	Normal	Normal
Medio plantar	Normal	Normal

Table 10: Deep Tendon Reflexes of LE

- **Superficial and Deep Sensation Examination:**
  - The following dermatomes were evaluated via light touch: C5 – C8 for the UE and L1 – L5 for the LE. According to the patient, sensation was the same bilaterally.
  - Deep sensation was tested through position sense and movement sense. The patient was successfully aware of both, implying no pathologies were present.

- **Examination of Pyramidal Signs:**

Upper Extremity		Lower Extremity	
Hoffman	Negative	Babinski	Negative
Juster	Negative	Chaddock	Negative
Trömner	Negative	Rossolimo	Negative

Table 11: Examination of UE and LE Pyramidal Signs

- No further neurological examinations were conducted as there were no concerning signs of a CNS lesion or disease.

Initial Examination Conclusion

Overall, the patient fared well in the kinesiological examinations relative to her state, being only two days post operation. The patient felt "very tired, weak and short of breath" towards the end of the examination. The patient was still bed ridden at the point of this initial examination; however, she was repositioned by the nurse staff every couple of hours. The postural examination revealed no other concerning problems that must be dealt with immediately through physiotherapy.

Pain in the abdomen was reflected in the breathing stereotype as the patent scarcely used that region during respiration. Breathing in the abdomen was felt minimally only in the ventral direction. Breathing predominantly took place in the upper thoracic area, however, even here it was shallow. The examination of reflex changes according to Lewit exhibited restricted soft tissue around the chest in all directions. It is presumed that the abdominal region was in a similar state due to the scar, however, it was not examined. The right forearm also had restricted soft tissue with the explanation most likely being the peripheral arterial catheter.

The orientational muscle examinations revealed that the triceps surae were shortened, primarily m. gastrocnemius bilaterally, presumably due to her age and lack of mobility. The strength tests showed she could do all movements against gravity, with her hip, wrist and shoulder joint even pushing against slight resistance by the therapist. Goniometry was performed only passively in order to save energy for the above-mentioned muscle strength tests. The most noticeable point was that the right side was overall less mobile, however, in

most instances this was because the movement was interrupted early due to pain. The patient felt her scar and abdomen stretch during larger movements such as shoulder flexion and hip flexion. Pain was read by monitoring the patients' facial expressions throughout each examination. Lastly, the neurological aspect of the examination uncovered no pathologies as the deep tendon reflexes were normal bilaterally, and both the cranial nerve tests and pyramidal signs resulted only in negatives.

3.4 SHORT-TERM AND LONG-TERM PHYSIOTHERAPEUTIC PLAN

Grounded by the initial kinesiological examinations, a short-term and long-term plan was conceived. The short-term therapy plan was focused on the brief period after the liver transplantation and was administered throughout the continual clinical practice at IKEM. Whereas the long-term plan had to be more fluid as it strongly depended on the progression of the patient's status. However, it focused on the period after the patient moved into the IPD and after they were released from the hospital.

Short-Term Physiotherapeutic Plan:

- VTE prevention
- Pressure ulcer prevention
- Respiratory physiotherapy
    - Improvement of airway clearance.
    - Phlegm mobilization (coughing of sputum)
    - Deepening/elongating the breathing
- Soft Tissue Techniques
    - Release restricted areas – chest, forearm, potentially abdomen.
- Maintaining ROM
- Stretching shortened muscles
- Strengthening weak muscles
    - Conditioning training - active movements
- Verticalization (with education)
    - Laying - Sitting
    - Sitting - Standing
- Gait practice with support.
    - High walker and physiotherapist support

Long-Term Physiotherapeutic Plan

- Scar care education
- Optimize breathing stereotype
- Further muscle strength
- Further muscle stretching
- Deep stabilization activation
- Training correct movement stereotypes
- Gait training with support
    - Potentially with low walker or French crutches
- ADL training

3.5 THERAPY PROGRESS

Note: The initial kinesiological examination was exhausting for the patient, so due to that and time constraints, the first therapy session began the following working day.

1. Therapy – 24/01/2022

Present Status:

Subjective: Patient still felt weak tired. She indicated she did not sleep well the night before. Her abdominal pain reduced to a 6/10 when aggravated by head movement.

Objective: Nurses verticalized the patient from laying to sitting over the weekend, however, the patient was not able to support themselves. She kept falling back. Patient was in supine position at the start of therapy and still had the tracheostomy connected with the ventilator set on SPONT. Crackles were palpable during exhalation.

- Heart rate: 80 beats/min
- Respiratory rate: 17 breaths/min
- SpO2: 97%

Therapy Goals:

- VTE prevention
- Pressure ulcer prevention
- Phlegm mobilization with sputum suction (through medical aspirator)
- Elongating and deepening breaths
- Maintaining ROM
- Strengthening muscles
- Improving elasticity of soft tissues in the chest
- Verticalization
    - Education

Therapy Proposal:

- Contact breathing (with vibrations for phlegm mobilization)
- STT for soft tissue elasticity
- Foam balling to facilitate breathing
  Active movements of UE and LE
- Verticalization from laying to sitting with support and comments from physiotherapists

Therapy Overview:

Contact breathing: I palpated the patient's chest to get a feel for their breathing wave. Following that, I began applying light pressure at the end of exhalation in the caudal, dorsal, and medial direction to elongate it and empty the lungs as much as possible. Then I released the pressure to allow the patient to inhale and I instructed her to follow my arms as I moved them cranially, ventrally, and laterally with the aim of causing a longer breath. In order to release the mucus that was causing the crackling, I began vibrating my palms as I applied pressure at the end of exhalation. During the vibrations, a nurse used a medical aspirator through the tracheostomy to suck out released sputum, suction was repeated three times.

Soft Tissue Techniques: Manuel stretching of the thoracic fascia was done in the lateral-medial direction with breathing. The fascia was stretched to its barrier, and I waited for

the release phenomenon. I began in the upper thoracic region and followed it down to the medial and then lower thoracic region, I performed this once per area on both sides.

Foam Balling: I did this in the chest region according to Ms. Jebavá. The aim of this was to further facilitate breathing.

Active Movements of UE and LE: The patient was not able to perform the movements alone as she felt too tired. So, I assisted her with the movement in order to activate the muscles. Each movement was repeated ten times. I began with the lower extremity to help prevent VTE diseases. Each movement was done until the end barrier was felt or ended early in case of pain. The movements we did were:

- Lower limbs:
  - Flexion and extension of the toes
  - Plantar and dorsal flexion of the ankle joint
  - Circumduction of the ankle joint
  - Flexion and extension in the knee joint (while keeping the heal on the bed)
  - Flexion in the hip joint.
  - Abduction in the hip joint followed by adduction.
- Upper limbs:
  - Closing and opening fists
  - Palmar and dorsal flexion of the wrist
  - Wrist circumduction
  - Flexion and extension in the elbow joint
  - Flexion in the shoulder joint to the end barrier
  - Abduction and adduction of the shoulder joint to the end of the barrier
  - External and internal shoulder rotation to the end of the barrier

Verticalization: Unfortunately, we did not attempt any verticalization this day because the patient did not want to as they felt too tired.

Results:

Following the contact therapy with pressure, her breath was elongated, and her ribs moved more laterally during inhalation. Her SpO2 also increased from 97% to 98%. Following the phlegm mobilization and suction, the crackling was much less palpable, but it did not disappear completely. The thoracic fascia felt more elastic by the end of the therapy, but it clearly did not reach the physiological barrier yet. Other than ankle and joint palmar and dorsiflexion, all the movements were active assisted. She explained that she simply was too sleepy. Verticalization was not possible due to her state, so she was allowed to stay in bed today. Before leaving, I returned all the decubitus pillows in the correct positions such as under the heels to prevent pressure ulcers.

Self-Therapy:

The patient was instructed to repeat some of the active movements we performed during the therapy session. She was told to do each movement within her limits. The goal was to maintain muscle strength and ROM. Furthermore, it helps avoid VTE diseases. These included:

- Flexion and extension of the toes
- Plantar and dorsal flexion of the ankle joint
- Circumduction of the ankle joint
- Flexion and extension in the knee joint (while keeping the heal on the bed)
- Closing and opening fists
- Palmar and dorsal flexion of the wrist
- Wrist circumduction
- Flexion and extension in the elbow joint

If the patient felt well enough, I said she may attempt the harder movements such as shoulder flexion too. The patient was told to do the movements listed above at least four times a with five - ten repetitions depending on her state.

2. Therapy – 25/01/2022

Present Status:

Subjective: Patient said she finally slept well. She still felt weak overall but appeared more energetic and ready for her therapy session. Her abdominal pain was still present at a 6/10 when aggravated by head movement.

Objective: Patient was in supine position at the start of therapy and still had the tracheostomy connected. However, the patient weaned off the ventilator, instead, used a humidifier with oxygen. This allowed her to speak when she covered the tracheostomy with her finger. Crackles were palpable during exhalation.

- Heart rate: 78 beats/min
- Respiratory rate: 17 breaths/min
- SpO2: 98%

Therapy Goals:

- VTE prevention
- Pressure ulcer prevention
- Phlegm mobilization with sputum coughing
- Elongating and deepening breaths
- Maintaining ROM
- Strengthening muscles
- Improving elasticity of soft tissues in the chest
- Verticalization
    - Education

Therapy Proposal:

- Contact breathing (with vibrations for phlegm mobilization)
- STT for soft tissue elasticity
- Foam balling to facilitate breathing
- Active movements of UE and LE
- Verticalization from laying to sitting with support and comments from physiotherapists

Therapy Overview:

Contact breathing: I palpated the patient's chest to get a feel for their breathing wave. Following that, I began applying light pressure at the end of exhalation in the caudal, dorsal, and medial direction to elongate it and empty the lungs as much as possible. Then I released the pressure to allow the patient to inhale and I instructed her to follow my palms as I moved them cranially, ventrally, and laterally with the aim of causing a longer breath. In order to release the mucus that was causing the crackling, I began vibrating my palms as I applied pressure at the end of exhalation.

Soft Tissue Techniques: Manuel stretching of the thoracic fascia was done in the lateral-medial direction with breathing. The fascia was stretched to its barrier, and I waited for the release phenomenon. I began in the upper thoracic region and followed it down to the medial and then lower thoracic region, I performed this once per area on both sides.

Foam Balling: I did this in the chest region according to Ms. Jebavá. The aim of this was to further facilitate breathing.

Active Movements of UE and LE: Each movement was repeated five times. She began with the lower extremity to help prevent VTE diseases. Each movement was done until the end barrier was felt or ended early in case of pain. The movements we did were:

- Lower limbs:
  - Flexion and extension of the toes
  - Plantar and dorsal flexion of the ankle joint
  - Circumduction of the ankle joint
  - Flexion and extension in the knee joint (while keeping the heal on the bed)
  - Flexion in the hip joint.
  - Abduction in the hip joint followed by adduction.
- Upper limbs:
  - Closing and opening fists
  - Palmar and dorsal flexion of the wrist
  - Wrist circumduction
  - Flexion and extension in the elbow joint

- Flexion in the shoulder joint to the end barrier
- Abduction and adduction of the shoulder joint to the end of the barrier
- External and internal shoulder rotation to the end of the barrier

Verticalization: Fortunately, since the patient was feeling better, with the support of myself and my supervisor, we were able to verticalize her from laying to sitting. This was done through instructing the patient to roll to right side with bent knees. Then she used the ipsilateral arm to push herself off the bed (with our support) while holding her scar with the contralateral arm.

Education: The patient was also instructed to hold her scar while coughing. Other than that, she was encouraged to not activate her abdomen as much as possible. That is why she was told to use her arms to push herself up while verticalizing herself too.

Results:

The patient's breath elongated, and she managed to use her lower ribs more as laterally during inhalation. She was able to successfully cough out sputum by herself when we lifted her upper body up with the bed. Crackling was less palpable following that, but not completely gone. The thoracic fascia felt more elastic by the end of the therapy, but it clearly did not reach the physiological barrier yet. The patient managed to do five repetitions of each movement actively, but I assisted her in shoulder flexion and hip flexion to reach further. The patient successfully verticalized from laying to sitting today. Even though it was not a part of the plan today, the patient managed to stand up for about half a minute with the support of two physiotherapists. She even proved to support herself once sitting up straight. However, she said it was uncomfortable for her abdomen. Before leaving, I returned all the decubitus pillows in the correct positions such as under the heels to prevent pressure ulcers. Since the patient was able to stand now, I conducted a general postural examination. The most noticeable points were: Both feet mildly externally rotated (normal), she had about 10cm between the heels. She appeared to lean on the medial edge of her feet bilaterally. Both her knees and ankles were valgus. Her shoulders were pronated bilaterally. Her head was central to the axis of the spine. She displayed lumbar lordosis.

Self-Therapy:

The self-therapy instructed to her today was the same as the previous day in order to further develop muscle strength and maintain ROM. The patient was instructed to do four separate sets with five to ten repetitions of each movement.

3. Therapy – 26/01/2022

Present Status:

Subjective: Patient was more talkative and energetic today. She said she was looking forward to therapy and hoped to stand up again. Her abdominal pain lowered to a 5/10, lifting the head did not aggravate it further anymore.

Objective: Patient was in supine position at the start of therapy and still had the tracheostomy connected. The patient weaned off the humidifier. She spoke by covering the tracheostomy with her finger. Crackles was much less palpable during exhalation.

- Heart rate: 74 beats/min
- Respiratory rate: 16 breaths/min
- SpO2: 98%

Therapy Goals:

- VTE prevention
- Pressure ulcer prevention
- Phlegm mobilization with sputum coughing
- Elongating and deepening breaths
- Maintaining ROM
- Strengthening muscles
- Improving elasticity of soft tissues in the chest
- Verticalization

Therapy Proposal:

- Contact breathing (with vibrations for phlegm mobilization)
- STT for soft tissue elasticity

- Foam balling to facilitate breathing
- Active movements of UE and LE
- Verticalization from laying to sitting with support of physiotherapists
- Verticalization from sitting to standing

Therapy Overview:

Contact breathing: I palpated the patient's chest to get a feel for their breathing wave. Following that, I began applying light pressure at the end of exhalation in the caudal, dorsal, and medial direction to elongate it and empty the lungs as much as possible. Then I released the pressure to allow the patient to inhale and I instructed her to follow my palms as I moved them cranially, ventrally, and laterally with the aim of causing a longer breath. I continued this for about two minutes. I applied contact in the abdominal region above the scar as well, but I did not apply pressure there, she only received the instruction to follow my hands. Even though it appeared much less phlegm was in the lungs, I decided to repeat the phlegm mobilization therapy by vibrating my palms during exhalation over the area I felt the most crackling.

Soft Tissue Techniques: Manuel stretching of the thoracic fascia was done in the cranio-caudal direction with breathing. The fascia was stretched to its barrier, and I waited for the release phenomenon. I began in the upper thoracic region and followed it down to the medial and then lower thoracic region, I performed this once per area on both sides. I also began slightly mobilizing the fascia around the scar as well. I never stretched or pulled the scar apart, but I moved in the direction of the scar.

Foam Balling: I did this in the chest region according to Ms. Jebavá. The aim of this was to further facilitate breathing.

Active Movements of UE and LE: Each movement was repeated five times. I began with the lower extremity to help prevent VTE diseases. Each movement was done until the end barrier was felt or ended early in case of pain. The movements we did were:

- Lower limbs:
    - Flexion and extension of the toes
    - Plantar and dorsal flexion of the ankle joint

        - Circumduction of the ankle joint
        - Flexion and extension in the knee joint (while keeping the heal on the bed)
        - Flexion in the hip joint.
        - Abduction in the hip joint followed by adduction.
    - Upper limbs:
        - Closing and opening fists
        - Palmar and dorsal flexion of the wrist
        - Wrist circumduction
        - Flexion and extension in the elbow joint
        - Flexion in the shoulder joint to the end barrier
        - Abduction and adduction of the shoulder joint to the end of the barrier
        - External and internal shoulder rotation to the end of the barrier

Verticalization from Laying to Sitting: We performed verticalization from laying to sitting once again with the same procedure. The patient rolled to right side with bent knees. Then she used the ipsilateral arm to push herself off the bed (with our support) while holding her scar with the contralateral arm.

Conditioning Training in Sitting: After the patent got to the sitting position, the patient was instructed to:

- Alternatively plantar and dorsal flexion the ankle joint
- Circumduction of the ankle joints in both directions
- Flexion and extension in the knee joints alternatively

Each movement was done up to ten times.

Verticalization from Sitting to Standing: Lastly, with the support of myself and my supervisor, the patient was instructed to push herself up with her arms off the bed and stand up. After standing she held onto a high walker and stood by herself for about a minute.

Results:

At this point the patient had a much deeper breath compared to the start of therapy. She managed to open her rib cage more ventrally and laterally. Importantly, she began using her abdominal region as it was palpable post contact respiration therapy. Once again, she was able to successfully cough out sputum by herself. However, this time she did it once she was sitting. Crackling was not palpable nor heard after she coughed. The thoracic fascia felt more elastic by the end of the therapy in this direction as well, it had a soft end feel but did not meet the physiological barrier. The patient managed to do five repetitions of each movement actively. The patient successfully verticalized from laying to sitting today. She again proved to support herself once sitting up straight. She even felt stable after standing up and holding onto the high walker. She stood up alone with the support of the high walker for about a minute before her head began spinning. She was immediately sat down with care after that. She had a wide base of support and leaned heavily on the high walker. She was dependant on it for stability, this meant she was hunched over and had deep kyphosis in her upper thoracic region. After two minutes passed, she opted to stand up again and we managed to make ten steps to the window and then back to her bed. She seemed pleased with the progression of her rehabilitation. Before leaving, I returned all the decubitus pillows in the correct positions such as under the heels to prevent pressure ulcers.

Self-Therapy:

The self-therapy instructed to her today was the same as the previous day in order to further develop muscle strength and maintain ROM. The patient was instructed to do five separate sets of ten repetitions of each movement. In addition to that, I kept the foam ball with the patient and told her to practice squeezing it three times a day with fifteen repetitions each time. Later, she was told to place her hands on her chest and practice breathing against them. She will start at the top, and after five slow breaths, she would move lower. She was told to focus on the upper, middle, and lower thoracic regions. She was instructed to do this four times a day with five repetitions per region.

4. Therapy – 27/01/2022

Present Status:

Subjective: Patient described herself being tired today again after a bad night sleep. She hoped she could walk today but does not think she can. Her abdominal pain lowered to a 4/10. She alerted us of anterior thigh aches, with the pain being a 5/10 when extending the knee.

Objective: Patient was in supine position at the start of therapy and still had the tracheostomy connected. Crackles returned but were very light during exhalation. She appeared to breath faster. Her rectus femoris was hypertonic after palpation. She was moved to the ICU after the therapy session.

- Heart rate: 80 beats/min
- Respiratory rate: 19 breaths/min
- SpO2: 97%

Therapy Goals:

- VTE prevention
- Pressure ulcer prevention
- Phlegm mobilization with sputum coughing
- Elongating and deepening breaths
- Maintaining ROM
- Quadriceps relaxation
- Improving elasticity of soft tissues in the chest and abdomen
- Stability training
- Verticalization
- Gait practice with high walker

Therapy Proposal:

- Contact breathing (with vibrations for phlegm mobilization)
- STT for soft tissue elasticity
- Foam balling to facilitate breathing
- Active movements of UE and LE

- PIR of rectus femoris
- Verticalization to standing
- Weight shifting in sitting and standing
- Walking with high walker

Therapy Overview:

Contact breathing: I palpated the patient's chest to get a feel for their breathing wave. Following that, I began applying light pressure at the end of exhalation in the caudal, dorsal, and medial direction to elongate it and empty the lungs as much as possible. Then I released the pressure to allow the patient to inhale and I instructed her to follow my palms as I moved them cranially, ventrally, and laterally with the aim of causing a longer breath. I continued this for about four minutes. I applied contact in the abdominal region above the scar as well, I even began applying slight pressure since she allowed it, she received the instruction to follow my hands. Since the phlegm returned, I repeated the phlegm mobilization therapy by vibrating my palms during exhalation over the area I felt the most crackling (in the middle thoracic region).

Soft Tissue Techniques: Manuel stretching of the thoracic fascia was done in all directions with breathing. The fascia was stretched to its barrier, and I waited for the release phenomenon. I began in the upper thoracic region and followed it down to the medial and then lower thoracic region, I performed this once per area on both sides. I continued to slightly mobilize the fascia around the scar as well. I never stretched or pulled the scar apart, but I moved in the direction of the scar.

Foam Balling: I did this in the chest region according to Ms. Jebavá. The aim of this was to further facilitate breathing.

Active Movements of UE and LE: Each movement was repeated five times. She began with the lower extremity to help prevent VTE diseases. Each movement was done until the end barrier was felt or ended early in case of pain. The movements we did were:

- Lower limbs:
    - Flexion and extension of the toes
    - Plantar and dorsal flexion of the ankle joint

        - Circumduction of the ankle joint
        - Flexion and extension in the knee joint (while keeping the heal on the bed)
        - Flexion in the hip joint.
        - Abduction in the hip joint followed by adduction.
    - Upper limbs:
        - Closing and opening fists
        - Palmar and dorsal flexion of the wrist
        - Wrist circumduction
        - Flexion and extension in the elbow joint
        - Flexion in the shoulder joint to the end barrier
        - Abduction and adduction of the shoulder joint to the end of the barrier
        - External and internal shoulder rotation to the end of the barrier

Stability Training in Sitting: After the patient was verticalized into the sitting position with the same procedure of raising up from side lying, the patient began weight shifting to train their stability. They were instructed to shift their weight back and forth slowly while supporting themselves for about a minute. Then they were instructed to do the same while transferring their weight left to right. However, due to fatigue, the patient was not able to do the same in standing this session.

PIR with of the rectus femoris: Due to the state of the patient, it was impossible to perform the traditional PIR procedure according to Lewit, so my supervisor and I improvised and got her to give slight resistance into knee extension while she was sitting. After ten seconds of resistance, the patient was instructed to deeply breath in, and as she exhaled, she relaxed the muscle. Then a new barrier was reached PIR was repeated three times in total. I followed that with five minutes of massaging the thigh.

Results:

Once again, the patient's breathing improved by the end of this therapy session. She managed to open her rib cage more ventrally and laterally. Importantly, she continued using her abdominal region as it was palpable post contact respiration therapy. She did not cough out any sputum, probably because there was so little of it. Crackling was not palpable nor heard after it was mobilized. The thoracic fascia felt more elastic by the

end of the therapy in all directions, it had a soft end feel but did not yet meet the physiological barrier. The patient managed to do five repetitions of each movement actively. The patient successfully verticalized from laying to sitting today. She again proved to support herself once sitting up straight. Her stability training went well, she did not appear to struggle. Unfortunately, due to fatigue, we did not stand up nor walk, however, we were able to relax her hypertonic rectus femoris bilaterally. The PIR and massage appeared to take effect as the tonicity drastically reduced in both rectus femoris. She mentioned her legs feeling much more relaxed and that the pain completely disappeared. Before leaving, I returned all the decubitus pillows in the correct positions such as under the heels to prevent pressure ulcers.

Self-Therapy:

Since she was fatigued, I told her to take a break from the active motions. However, I told her to continue both of the other therapies including squeezing the foam ball and breathing against her hands on her chest.

5. Therapy – 28/01/2022

Present Status:

Subjective: After a good night sleep, she felt reenergized. She described being hopeful to make up for what she missed last time. She did not feel any abdominal pain nor anterior thigh pain/aches. She was happy and looking forward to the therapy session.

Objective: Patient was in supine position at the start of therapy and still had the tracheostomy connected. Crackles were not palpated or heard. Her breaths were slower. Her rectus femoris appeared to be in normal tonicity now.

- Heart rate: 78 beats/min
- Respiratory rate: 16 breaths/min
- SpO2: 99%

Therapy Goals:

- Elongating and deepening breaths
- Improving ROM

- Improving elasticity of soft tissues in the chest and abdomen
- Stability training
- Verticalization
- Gait practice with high walker

Therapy Proposal:

- Contact breathing
- STT for soft tissue elasticity
- Foam balling to facilitate breathing
- Active movements of UE and LE
- Verticalization to standing
- Weight shifting in standing
- Walking with high walker

Therapy Overview:

Contact breathing: I palpated the patient's chest to get a feel for their breathing wave. Following that, I began applying light pressure at the end of exhalation in the caudal, dorsal, and medial direction to elongate it and empty the lungs as much as possible. Then I released the pressure to allow the patient to inhale and I instructed her to follow my palms as I moved them cranially, ventrally, and laterally with the aim of causing a longer breath. I continued this for about five minutes. I applied contact respiratory therapy in the abdominal region above the scar as well, I applied even pressure to the chest as she allowed it, she received the instruction to follow my hands. No vibration was included as there were no signs of phlegm build up.

Soft Tissue Techniques: Manuel stretching of the thoracic fascia was done in all directions with breathing. The fascia was stretched to its barrier, and I waited for the release phenomenon. I stretched the whole thoracic region and the tissue surrounding the scar. I applied less pressure around the scar. I never stretched or pulled the scar apart, but I moved in the direction of the scar.

Active Movements of UE and LE: Each movement was repeated up to ten times. The patient was instructed to begin with the lower extremity to help prevent VTE diseases. The movements she did were:

- Lower limbs:
  - Flexion and extension of the toes
  - Plantar and dorsal flexion of the ankle joint
  - Circumduction of the ankle joint
  - Flexion and extension in the knee joint (while keeping the heal on the bed)
  - Flexion in the hip joint.
  - Abduction in the hip joint followed by adduction.
- Upper limbs:
  - Closing and opening fists
  - Palmar and dorsal flexion of the wrist
  - Wrist circumduction
  - Flexion and extension in the elbow joint
  - Flexion in the shoulder joint to the end barrier
  - Abduction and adduction of the shoulder joint to the end of the barrier
  - External and internal shoulder rotation to the end of the barrier

Stability Training in Standing: After the patient was verticalized into the standing position. While holding onto the high walker, the patient was instructed to begin swaying their weight from right to left. By pressing their weight on one leg and then the other. After they did this for about one-minute they were instructed to do the same back and forth for another minute.

Gait Practice with the High Walker: We took advantage of the fact the patient had more energy today and went walking. The patient walked about 30m in total, she walked outside of the room, had a look at the hallway aquarium, and then returning without need a break to sit down. Since this was the first time, I saw the patient properly walk, I made observations to do a general gait examination: Her strides were short, fast and symmetrical. Her base of support widened compared to when she was standing. This

implies the patient did not fully feel stable while walking. Her gait pattern was physiological, beginning with heel strike and finished with the toe off stage.

Results:

Once again, the patient's breathing improved by the end of this therapy session. Her breaths were deeper and elongated. She managed to introduce the abdomen into her breathing stereotype. However, it was relatively shallow at the abdominal area. The thoracic fascia felt more elastic by the end of the therapy in all directions, it had a soft end feel, and it felt that it met the physiological barriers. The tissue around the scar and abdomen felt restricted. The patient managed all the active movements alone with improved ROM. The patient successfully verticalized from laying to sitting today without assistance. Her stability training went well again as she did not appear to struggle. Gait practice was a success as she walked 30 meters without needing to sit down. A nurse detached her from her the monitors as usual and we took the urinary catheter along for the walk. The patient did not stumble; however, she had a bad habit of looking down. She also took noticeably short strides. Therefore, she was repeatedly informed to look in front of her and slow and extend her strides. When the patient arrived back to her room, the nurses prepared her a sofa so she sat there so she could get cleaned rather than laying down.

Self-Therapy:

The patient was again asked to repeat the active movements performed this therapy session. She was told to do two sets of five repetitions each. Following that the auto-therapy was the same, however, she was told to begin putting her hands on her abdomen and practice breathing there too.

6. Therapy – 31/01/2022

Present Status:

Subjective: Patient mentioned sleeping well and was in a good mood as to be expected at this point. She was looking forward to walking further this session. She highlighted pain in the abdominal region and around the scar.

Objective: Patient was already in a sofa at the start of therapy and still had the tracheostomy connected. Crackles were not palpated or heard. Her breaths were slower. Her abdominal fascia was markedly restricted. The scar was left out without bandages anymore. The patient was moved to the IPD prior to the therapy session.

- Heart rate: 78 beats/min
- Respiratory rate: 16 breaths/min
- SpO2: 99%

Therapy Goals:

- Elongating and deepening breaths
- Improving ROM
- Scar care
- Improving elasticity of soft tissues in the abdomen
- Stability training
- Verticalization
- Gait practice with high walker

Therapy Proposal:

- Contact breathing
- STT for soft tissue elasticity and the scar
- Active movements of UE and LE
- Verticalization without support
- Weight shifting in standing
- Walking with high walker

Therapy Overview:

Contact breathing: I palpated the patient's chest to get a feel for their breathing wave. Following that, I began applying light pressure at the end of exhalation in the caudal, dorsal, and medial direction to elongate it and empty the lungs as much as possible. Then I released the pressure to allow the patient to inhale and I instructed her to follow my palms as I moved them cranially, ventrally, and laterally with the aim of causing a longer breath. I continued this for about five minutes. I applied contact respiratory

therapy in the abdominal region above the scar as well, I applied even pressure to the chest as she allowed it, she received the instruction to follow my hands. No vibration was included as there were no signs of phlegm build up.

Soft Tissue Techniques: Manuel stretching of the abdominal fascia was conducted in directions following the scar. The fascia was stretched to its barrier, and I waited for the release phenomenon. I stretched the tissue around the scar as well, but always moved parallel to the scar and not against it.

Active Movements of UE and LE: Each movement was repeated up to ten times. The patient was instructed to begin with the lower extremity to help prevent VTE diseases. The movements she did were:

- Lower limbs:
  - Flexion and extension of the toes
  - Plantar and dorsal flexion of the ankle joint
  - Circumduction of the ankle joint
  - Flexion and extension in the knee joint (while keeping the heal on the bed)
  - Flexion in the hip joint.
  - Abduction in the hip joint followed by adduction.
- Upper limbs:
  - Closing and opening fists
  - Palmar and dorsal flexion of the wrist
  - Wrist circumduction
  - Flexion and extension in the elbow joint
  - Flexion in the shoulder joint to the end barrier
  - Abduction and adduction of the shoulder joint
  - External and internal shoulder rotation to the end barrier

Stability Training in Standing: This was the same as the last session, the patient trained for a total of five minutes by transiting weight in multiple directions. To add a challenge, I held her shoulders and softly tried moved her in different directions after giving her the instruction to stand still.

Gait Practice with the High Walker: The patient walked about 50m in total, she walked outside of the room and then two lengths of the hallway.

Results:

The patient's breathing improved by the end of this therapy session. Her breaths were deeper and elongated. She continued to introduce the abdomen more into her breathing stereotype. However, it was still relatively shallow at the abdominal area. The abdominal fascia was suspected of tightening because she admitted to overtraining. She was anxious to heal faster and most probably overdid it. Since PIR of the abdominal muscles was not safe due to the scar, I did fascia release and it appeared to help. The fascia reaches their physiological end barriers with soft end feels and the patient described feeling relaxed and said the pain left. The patient managed all the active movements alone with improved ROM. The patient successfully verticalized from laying to sitting today without assistance. She was even able to verticalize into standing alone by holding onto the high walker. Her stability training went well again as she did not appear to struggle. Gait practice was a success again as she walked over 50 meters without needing or wanting a break. The patient even improved at looking forward rather than at her feet. However, she still needed to be reminded to extend her strides and slow down.

Self-Therapy:

The patient was again asked to repeat the active movements performed this therapy session. She was told to do five sets of fifteen repetitions each. She was also instructed to similarly do fascia stretching of her right forearm since the peripheral arterial catheter was removed. I taught her how to do it correctly. Following that the auto-therapy was the same with the ball squeezing and breathing exercise.

7. Therapy – 01/02/2022

Present Status:

Subjective: Patient mentioned sleeping well again, she was looking forward to walking again. She once again highlighted pain in the abdominal region and around the scar.

Objective: Patient in supine position when therapy started and still had the tracheostomy connected. Crackles were not palpated or heard. Her abdominal fascia was restricted. The scar was left out without bandages anymore. My supervisor and I agreed that the patient would attempt to walk with French crutches today.

- Heart rate: 76 beats/min
- Respiratory rate: 16 breaths/min
- SpO2: 99%

Therapy Goals:

- Elongating and deepening breaths
- Improving ROM
- Scar care
- Improving elasticity of soft tissues in the abdomen
- Stability training
- Verticalization
- Gait practice with French crutches
- Muscle strength

Therapy Proposal:

- Contact breathing
- STT for soft tissue elasticity and the scar
- Active movements of UE and LE
- Verticalization without support
- Weight shifting in standing
- Walking with French crutches
- PNF according to Kabat

Therapy Overview:

Contact breathing: I began applying light pressure at the end of exhalation in the caudal, dorsal, and medial direction to elongate it and empty the lungs as much as possible. Then I released the pressure to allow the patient to inhale and I instructed her to follow my palms as I moved them cranially, ventrally, and laterally with the aim of causing a

longer breath. I continued this for about five minutes. I applied contact respiratory therapy in the abdominal region above the scar as well, I applied even pressure to the abdomen as she allowed it, she received the instruction to follow my hands.

Soft Tissue Techniques: Manuel stretching of the abdominal fascia was conducted again in directions following the scar. The fascia was stretched to its barrier, and I waited for the release phenomenon. I stretched the tissue around the as well, but always moved parallel to the scar and not against it.

Active Movements of UE and LE: Each movement was repeated up to ten times. The patient was instructed to begin with the lower extremity to help prevent VTE diseases. The movements she did were:

- Lower limbs:
  - Flexion and extension of the toes
  - Plantar and dorsal flexion of the ankle joint
  - Circumduction of the ankle joint
  - Flexion and extension in the knee joint (while keeping the heal on the bed)
  - Flexion in the hip joint.
  - Abduction in the hip joint followed by adduction.
- Upper limbs:
  - Closing and opening fists
  - Palmar and dorsal flexion of the wrist
  - Wrist circumduction
  - Flexion and extension in the elbow joint
  - Flexion in the shoulder joint to the end barrier
  - Abduction and adduction of the shoulder joint
  - External and internal shoulder rotation to the end barrier

PNF according to Kabat: The patient performed both the first and second diagonal of the upper extremity successively. This was done to provide strengthening for a variety of UE muscles. I did not perform PNF on the LE as gait practice would suffice.

Stability Training in Standing: This was the same as the last session, the patient trained for a total of two minutes by transiting weight in multiple directions. To add a challenge, I held her shoulders and softly tried moved her in different directions after giving her the instruction to stand still.

Gait Practice with the High Walker: The patient walked about 20m with the high walker before returning to the bed and trying the French crutches. She ended up walking the whole hallway again meaning she walked over 50m again.

Results:

The patient's breathing has drastically improved since the beginning and is much deeper and has a better flow. She uses her abdomen more into her breathing stereotype. The abdominal fascia was suspected to still be tight because of overtraining. The fascia reaches their physiological end barriers with soft end feels and the patient described feeling relaxed and said the pain left. The patient managed all the active movements alone with improved ROM. She struggled to coordinate her movements during PNF, I believe that our language barrier only made the situation more complicated. After a couple of explanations and repetitions later, she improved her coordination. She pressed against slight resistance. The patient successfully verticalized from laying to sitting today without assistance. She was even able to verticalize into standing alone by holding onto the high walker. Her stability training went well again as she did not appear to struggle. Gait practice was a success again as she walked over 50 meters without needing or wanting a break. Initially, the patent was cautions and anxious while adapting to the new French crutches, but she quickly adjusted to them. Her adjustment period was relatively quick as she used them previously due to past injuries. As a, unplanned bonus, the patient attempted one flight of stairs. My supervisor and I instructed the patient how to properly walk up and down stairs with French crutches and she followed well.

Self-Therapy:

The auto-therapy was the same as previous sessions. The patient was told to practice active movements, breathing and strengthening the hand with the foam ball. The patient was additionally asked to sit up while eating her meals without support of the bed.

8. Therapy – 02/02/2022

Present Status:

Subjective: Patient mentioned sleeping well again, she was looking forward to walking again. She did not mention any pain in the abdomen this time. However, she emphasized pain in both calf muscles. She was looking forward to practicing stairs more.

Objective: Patient in supine position when therapy started and still had the tracheostomy connected. Crackles were not palpated or heard. Her abdominal fascia was not restricted, however, her triceps surae were hypertonic bilaterally. The scar was left out without bandages anymore. She was being discharged from the hospital later that day.

- Heart rate: 74 beats/min
- Respiratory rate: 16 breaths/min
- SpO2: 99%

Therapy Goals:

- Elongating and deepening breaths
- Improving ROM
- Relax both triceps surae muscles.
- Scar care
- Improving elasticity of soft tissues in the abdomen and chest
- Stability training
- Verticalization
- Gait practice with French crutches and without them
- Training Stairs

Therapy Proposal:

- Contact breathing
- STT for soft tissue elasticity and the scar
- PIR of gastrocnemius and soleus muscles bilaterally
- Scar care education

- Active movements of UE and LE
- PNF according to Kabat
- Verticalization without support
- Weight shifting in standing
- Gait with French crutches and without support
- Training stairs with French crutches

Therapy Overview:

Contact breathing: I began applying light pressure at the end of exhalation in the caudal, dorsal, and medial direction to elongate it and empty the lungs as much as possible. Then I released the pressure to allow the patient to inhale and I instructed her to follow my palms as I moved them cranially, ventrally, and laterally with the aim of causing a longer breath. I continued this for about five minutes. I applied contact respiratory therapy in the abdominal region above the scar as well, I applied even pressure to the abdomen as she allowed it, she received the instruction to follow my hands.

Soft Tissue Techniques: Manuel stretching of the abdominal and chest fascia was conducted again in directions following the scar. The fascia was stretched to its barrier, and I waited for the release phenomenon. I told the patient to watch as I did this therapy, and then I specially showed and explained how to care for the scar. I emphasized to wait till the stitches were released and the scar closed up. I showed her the C shape, the S shape therapy and lastly pressure therapy.

Active Movements of UE and LE: Each movement was repeated up to ten times. The patient was instructed to begin with the lower extremity to help prevent VTE diseases. The movements she did were:

- Lower limbs:
  - Flexion and extension of the toes
  - Plantar and dorsal flexion of the ankle joint
  - Circumduction of the ankle joint
  - Flexion and extension in the knee joint (while keeping the heal on the bed)
  - Flexion in the hip joint.

        - Abduction in the hip joint followed by adduction.
    - Upper limbs:
        - Closing and opening fists
        - Palmar and dorsal flexion of the wrist
        - Wrist circumduction
        - Flexion and extension in the elbow joint
        - Flexion in the shoulder joint to the end barrier
        - Abduction and adduction of the shoulder joint
        - External and internal shoulder rotation to the end barrier

PNF according to Kabat: The patient performed both the first and second diagonal of the upper extremity successively. This was done to provide strengthening for a variety of UE muscles. I did not perform PNF on the LE as gait practice would suffice. Today I applied more resistance.

Stability Training in Standing: This was the same as the previous session.

PIR with of triceps surae: The patient was not able to lay down prone to perform the PIR of soleus according to Janda, therefore my supervisor and I improvised and got her to give slight resistance into plantar flexion of the foot while she was sitting with her knees flexed at 90°. PIR of the gastrocnemius was performed according to Janda. PIR was performed three times per muscle bilaterally.

Gait Practice with French crutches and without support: The patient verticalized themselves without support and handled standing without trouble. They walked immediately with the French crutches and managed to walk 50m before reaching the stairs. After that she followed our instructions again and walked up and down them. On the way back to the room, my supervisor took the crutches and the patent held onto me and attempted to walk without crutches.

Results:

The patient's breathing has drastically improved since the beginning. Her stereotype improved and included the abdomen. The fascia reached their physiological barriers and had soft feels. The patient managed all the active movements alone with improved

ROM. Her coordination during PNF improved. She found this exercise fun as it was a puzzle for her mind. She pressed against increased resistance relative to the last session. The patient successfully verticalized herself from laying to standing, and then proceeded to effortlessly practice stability. The patient was happy to admit she did not feel her calf pain anymore. She even admitted that she felt more relaxed during gait training. Gait practice was a success again as she walked over 50 meters without needing or wanting a break. She managed the stairs as well, but she did need a break at the top before we continued down. She followed instructions well and did not need reminding how to walk up and down stairs.

Self-Therapy:

The patient returned the foam ball, but I instructed her to find a shirt or some other item at home and continue the same exercise. She was also instructed to continue breathing against her hands while elongating her breath. Lastly, the patient was reminded to care for the scar at home. She was told to massage the scar up to three times a day, with each session taking up to five minutes minimum.

3.6 FINAL KINESIOLOGICAL EXAMINATION

The examination was performed on 03/02/2022.

Present Status:

Subjective: Patient was in a good mood; she was pleased with her progress over the last two weeks. She did not highlight any aches or pains. Her only complaint was that she did not feel confident walking up and down stairs alone.

Objective: Patient was located in the Inpatient Department (IPD), she was fifteen days post operation. She still had a tracheostomy, but her permanent urinary catheter, surgical drain, peripheral arterial catheter, and central venous catheter were removed. Patient was now able to speak clearly while covering her tracheostomy. Patient appeared to follow conversations well and seemed oriented in time, space, and self.

- Height: 158cm
- Weight: 5kg

- BMI, BSA, somatotype: 23.6, 1.61m^2, Endomorph
- Heart rate: 74 beats/min
- Respiratory rate: 16 breaths/min

Static Postural Examination

In the initial kinesiological examination, posture was only assessed in supine position due to the state of the patient. Fortunately, due to the patient's advancement, the examination was now accomplished in standing without support. The patient displayed a physiological skin colour.

<table>
<tr><th>Anterior View</th><th>Posterior View</th></tr>
<tr><td>Base of support: Both feet mildly externally rotated (normal). There is 8cm between the heels. Patient appears to lean on the medial edge of the feet bilaterally.</td><td rowspan="9">Everything relates from the anterior view.
Additionally:
The right Achilles tendon appeared thicker. Both of them curved medially.
The right popliteal line appeared mildly higher, by less than a centimetre. Both had the same angle.
Same applies with the sub gluteal line.
Right shoulder appeared lower.
Prominence of medial boarder of scapulae bilaterally.
Head is in the correct axis.</td></tr>
<tr><td>Ankle: Mild case of valgus ankles bilaterally.</td></tr>
<tr><td>Knee: Mild case of valgus knees bilaterally, patellae slightly externally rotated bilaterally.</td></tr>
<tr><td>Pelvis: Right ASIS minimally higher (confirmed by palpation).</td></tr>
<tr><td>Shoulders: Pronated shoulders bilaterally</td></tr>
<tr><td>Forearm: Elbow not fully extended with the forearm pronated.</td></tr>
<tr><td>Scar: Still red, stitches still in place.</td></tr>
<tr><td>Umbilicus: Central, it is in the axis. Abdomen appeared more firm, indicating more muscle tonus.</td></tr>
<tr><td>Head: Central, in the axis of the spine.</td></tr>
<tr><th colspan="2">Lateral View</th></tr>
<tr><td colspan="2">Everything relates from the anterior and posterior view.
Additionally:
Patient’s head slightly protracted.
Patient displayed kyphotic lower cervical spine.
Hip joint was in slight anteflexion (confirmed by palpation).
Lumbar spine had deeper lordosis
Shoulders were again protracted bilaterally.</td></tr>
</table>

Table 12: Postural Examination in Standing

Gait Examination:

Patient did the gait examination with French crutches. She followed the 4-point crutch gait. She walked up and down her room to perform this examination. Her strides lengthened since the start; however, they were still relatively short and fast. However, the strides were symmetrical. Her base of support widened from 8cm to about 12cm. This implies the patient

did not fully feel stable while walking. Her gait pattern was physiological, beginning with heel strike and finished with the toe off stage.

Her arms swung physiologically, meaning the opposing UE and LE moved together. The patient did not extend their hip joint bilaterally Her gait mostly resembled the distal stereotype of gait according to Janda.

Assessment of Breathing Stereotype:

The examination was demonstrated only in supine position again so it can be compared to the initial examination. Significantly, the patient was not connected to the ventilator anymore. This meant the patient had self-competent lungs.

Once again, the examination was done through aspection, palpation and listening. Whilst doing so, it was clear that there was no excess phlegm within the lungs as there was no cracking.

The patient still predominantly used the upper thoracic region; however, the overall breath was longer and deeper. She also managed to incorporate the abdomen into her stereotype. Whilst the abdominal breathing was shallow, at the start it was non-existent. Overall, the breath felt deeper and more 3D as the ribs more ventrodorsally, lateral-medially, and antero-posteriorly.

The breath was still not symmetrical as the left side was more prevalent during palpation. Nevertheless, it was less noticeable. The breathing frequency was 16 breaths/min, and the intensity was about 2cm.

Examination of Reflex Changes according to Lewit

I assessed the skin, subcutaneous tissue, and fascia of the chest, abdomen, and lower and upper limbs. I further investigated the muscle tone of the lower and upper limbs. The skin, subcutaneous tissue, and fascia was physiological with soft end feels. Despite certainly improving, Both the upper and lower extremities revealed unrestricted skin, subcutaneous tissue, and fascia. Regarding muscle tonus, the upper and lower extremities felt physiological. However, her triceps surae were hypertonic again since the last therapy session.

Body Region		State of Fascia
Scalp		Normal
Neck		Normal
Chest		Normal
Abdomen		Normal
Back		Did not examine
Limbs	UE	Normal
	LE	Normal

Table 13: Reflex Changes according to Lewit - Fascia

Anthropometric Examination by Haladová

UPPER EXTREMITY	Left Extremity	Right Extremity
Length (cm)		
Whole Arm	67	67
Humerus	30	30
Forearm	37	37
Hand	19	19
Circumference (cm)		
Upper Arm Relaxed	32	33
Upper Arm Flexed	32	33
Elbow	29	29
Forearm	27	27
Wrist	17	17
Metacarpal Head	23	23

Table 14: Anthropometric Lengths and Circumferences of UE

LOWER EXTREMITY	Left Extremity	Right Extremity
Length (cm)		
Anatomical	81	81
Functional	90	90
Thigh	45	45
Lower-Leg	35.5	35.5
Foot	24	24
Circumference (cm)		
Rectus	47	47.5
Vastus	45	45
Knee	38	37
Calf	31	31
Ankle	23	23
Heel	31	31
Metacarpal Head	23	23

Table 15 - Anthropometric Lengths and Circumferences of LE

Goniometric Examination by Janda

Due to the condition of the patient, she could not lay prone, so some goniometric examinations were modified.

Joint	Plane	Left Extremity	Right Extremity
Shoulder	S	30 – 0 - 180	30 – 0 – 170
	F	170 – 0 – 0	170 – 0 – 0
	T	90 – 0 – 80	90 – 0 – 80
	R	80 – 0 – 60	70 – 0 – 50
Elbow	S	0 – 0 – 160	0 – 0 – 150
Radio - Ulnar	R	75 – 0 – 70	70 – 0 – 60
Wrist	S	75 – 0 – 80	70 – 0 – 80
	F	15 – 0 – 15	15 – 0 – 15

Table 16: Passive Goniometry of UE

Joint	Plane	Left Extremity	Right Extremity
Hip	S	10 – 0 – 110	10 – 0 – 100
	F	40 – 0 - 10	40 – 0 – 10
	R	Not Examined	Not Examined
Knee	S	0 – 0 – 130	0 – 0 – 125
Ankle	S	20 – 0 – 30	20 – 0 – 30
	R	10 – 0 – 15	10 – 0 – 15

Table 17: Passive Goniometry of LE

Joint	Plane	Left Extremity	Right Extremity
Shoulder	S	20 – 0 - 150	20 – 0 – 150
	F	140 – 0 – 0	140 – 0 – 0
	T	20 – 0 – 60	20 – 0 – 65
	R	70 – 0 – 50	65 – 0 – 50
Elbow	S	0 – 0 – 140	0 – 0 – 140
Radio - Ulnar	R	60 – 0 – 60	60 – 0 – 50
Wrist	S	70 – 0 – 70	70 – 0 – 70
	F	10 – 0 – 10	10 – 0 – 10

Table 18: Active Goniometry of UE

Joint	Plane	Left Extremity	Right Extremity
Hip	S	10 – 0 – 90	10 – 0 – 90
	F	40 – 0 - 10	40 – 0 – 10
	R	Not Examined	Not Examined
Knee	S	0 – 0 – 120	0 – 0 – 120
Ankle	S	10 – 0 – 20	10 – 0 – 20
	R	10 – 0 – 15	10 – 0 – 15

Table 19: Active Goniometry of LE

Muscle Strength Examination by Janda

Due to the condition of the patient, the patient could not lay prone, so some muscle examinations were modified.

Joint	Movement	Muscles Involved	Left Extremity	Right Extremity
Shoulder	Flexion	Coracobrachialis Deltoideus (Clavicular part)	4	4
	Extension	Deltoids (Scapular part) Teres Major Latissimus Dorsi	4 -	4 -
	Abduction	Deltoideus (Acromial part) Supraspinatus	4	4
	Horizontal Adduction	Pectorals major	4	4
	External Rotation	Posterior deltoid Infraspinatus Teres minor	4	4
	Internal Rotation	Anterior deltoid Teres major Pectoralis major Subscapularis	4	4
Elbow	Flexion	Biceps Brachii Brachialis Brachioradialis	4	4
	Extension	Triceps brachii Anconaeus	4	4
Wrist	Dorsi Flexion	Extensor Carpi Ulnaris Extensor carpi radialis longus and brevis	4	4
	Palmar Flexion	Flexor Carpi Ulnaris Flexor Carpi Radialis	4	4

Table 20: Muscle Strength Test of UE

Joint	Movement	Muscles Involved	Left Extremity	Right Extremity
Hip	Flexion	Iliopsoas	4	4
	Extension	Gluteus Maximus Ischiocrural Muscles	4	4
	Abduction	Gluteus Medius/Minimus TFL	4	4
	Adduction	Adductor Magnus, Longus/Brevis Gracilis Pectineus	4	4
Knee	Flexion	Biceps Femoris Semitendinosus Semimembranosus	4 -	4 -
	Extension	Quadriceps Femoris	4 -	4 -
Ankle	Supination with dorsal flexion	Tibialis Anterior	4 -	4 -
	Palmar Flexion	Triceps Surae	4 -	4 -
	Supination with palmar flexion	Tibialis Posterior	4	4
	Plantar pronation	Peroneus Brevis/Longus	4	4

Table 21: Muscle Strength Test of LE

Muscle Length Examination by Janda

Muscle Group	Left Extremity	Right Extremity
M. Soleus	1	1
M. Gastrocnemius	1	1
Knee Flexors	1	1
Knee Extensors	Not Examined	Not Examined
Long Adductors	1	1
Short Adductors	1	1

Table 22: Muscle Length Test of LE

Both the muscle strength and length tests were orientational, only the same assessments were completed as the initial examination.

Neurological Examinations

- **Cranial Nerve Tests:**
    - The examination of the twelve cranial nerves produced all negative results, meaning the patient was free of pathological symptoms.
    - The only difference from the initial examination was that the hypoglossal nerve was tested since the patient was disconnected from the ventilator and could speak: The patient was able to communicate and articulate words without any problems. She pronounced words clearly and did not stutter. Therefore, there was no suspicion of a lesion in this nerve either.
- **Deep Tendon Examination:**

Reflex	Left Extremity	Right Extremity
Biceps	Normal	Normal
Triceps	Normal	Normal
Brachioradialis	Normal	Normal

Table 23: Deep Tendon Reflexes of UE

Reflex	Left Extremity	Right Extremity
Patellar	Normal	Normal
Achilles	Normal	Normal
Medio plantar	Normal	Normal

Table 24: Deep Tendon Reflexes of LE

- **Superficial and Deep Sensation Examination:**
    - The following dermatomes were evaluated via light touch: C5 – C8 for the UE and L1 – L5 for the LE. According to the patient, sensation was the same bilaterally.

- Deep sensation was tested through position sense and movement sense and the patient was successfully aware of both. This implies no pathologies were present.

- **Examination of Pyramidal Signs:**

Upper Extremity		Lower Extremity	
Hoffman	Negative	Babinski	Negative
Juster	Negative	Chaddock	Negative
Trömner	Negative	Rossolimo	Negative

Table 25: Examination of UE and LE Pyramidal Signs

- No further neurological examinations were conducted as there were no concerning signs of a CNS legion or disease.

Final Examination Conclusion:

The patient was in a better condition than the start as they were mobile, meaning they verticalized and walked themselves. The patient used a walking aid (French crutches) when walking longer distances outside their room. She had a distal gait stereotype, which entailed hypertonicity of the triceps surae muscles due to overuse. She even managed to climb one flight of stairs with the support of a physiotherapist. The postural examination revealed that some right LE components were elevated such as the gluteal line, popliteal line, and ASIS. It also revealed that the patient had valgus toes, ankles, and knees.

The breathing stereotype persisted to primarily take place in the upper thoracic region, however, it did deepen in all directions. Crackling was not present during the examination. The examination of reflex changes according to Lewit presented physiological barriers and soft end feels in the thoracic, UE and LE fascia. The abdomen also showed unrestricted fascia, however, this was not the case with the tissue surrounding the scar. That tissue will be focused on more when proper scar care can take place (after wounds heal from the removed stitches).

The muscle examinations showed that short muscles did not fully stretch, however, the marked shortness of the gastrocnemius reduced. The strength tests showed she could do all movements at against medium resistance. The knee could only push against light resistance. Goniometry was performed actively and passively. Most of the movements were symmetrical

now. Despite not reach many norms of ROM, the patient did improve. Previously the patent was not even able to perform active movements, so doing so for the final examination further proves muscle strength improved. The bandages were removed from the scar, but the staples/stiches were still kept in, therefore proper scar care was not possible yet. The patient was educated what to do when the scar is ready. Lastly, the patient showed no neurological pathologies. The deep tendon reflexes were normal bilaterally, and both the cranial nerve tests and pyramidal signs resulted only in negatives.

3.7 EVALUATION OF THERAPY EFFECTIVENESS

During my continuous month of clinical practice at IKEM, the patient underwent eighth therapy sessions with me. She considerably improved between the first and final kinesiological examinations. At the start, the patient was being bed ridden, connected to a ventilator, marked 7/10 pain, and struggled to perform active movements. At the end, the patient performed active movements with relative ease, walked up to 50m (with crutches) and indicated no pain.

The patient was truly motivated each session and wanted to progress towards improving her health and condition. She was eager to return home and to her ADL. All goals set in the short-term therapy plan were met, with the primary ones being ADL preparation, verticalization, muscle strength and stretching, and gait practice.

The neurological assessment presented no pathologies. Whilst all other examinations represented positive improvement. Her goniometric values did not reach accepted norms in several joints, however, for her age and her ADL it was acceptable. More importantly, she improved her ROM since the start. The tables below clearly illustrate the progress the patient made with muscle strength and length:

Joint	Movement	Initial Examination		Final Examination	
		Left Extremity	Right Extremity	Left Extremity	Right Extremity
Shoulder	Flexion	3	3	4 -	4
	Extension	Not Examined	Not Examined	4 -	4 -
	Abduction	4 -	4 -	4	4
	Horizontal Adduction	4 -	4 -	4	4
	External Rotation	4 -	4 -	4	4
	Internal Rotation	4 -	4 -	4	4
Elbow	Flexion	4	4	4	4
	Extension	4 -	4 -	4 -	4
Wrist	Dorsi Flexion	4	4	4	4
	Palmar Flexion	4	4	4	4

Table 26: Comparison of UE Muscle Strength according to Janda

Joint	Movement	Initial Examination		Final Examination	
		Left Extremity	Right Extremity	Left Extremity	Right Extremity
Hip	Flexion	4 -	4 -	4	4
	Extension	Not Examined	Not Examined	4	4
	Abduction	4 -	4 -	4	4
	Adduction	4 -	4 -	4	4
Knee	Flexion	3	3	4 -	4 -
	Extension	Not Examined	Not Examined	4 -	4 -
Ankle	Supination with dorsal flexion	3	3	4 -	4 -
	Palmar Flexion	3	3	4 -	4 -
	Supination with palmar flexion	3+	3+	4	4
	Plantar pronation	3+	3+	4	4

Table 27: Comparison of LE Muscle Strength according to Janda

Muscle Group	Initial Examination		Final Examination	
	Left Extremity	Right Extremity	Left Extremity	Right Extremity
M. Soleus	1	1	1	1
M. Gastrocnemius	1	1	1	1
Knee Flexors	1	1	1	1
Knee Extensors	Not Examined	Not Examined	Not Examined	Not Examined
Long Adductors	1	1	1	1
Short Adductors	1	1	1	1

Table 28: Comparison of LE Muscle Length according to Janda

Lastly, the patient's breathing improved significantly. In the beginning she required a ventilator to aid her breathing. Her lungs had excess phlegm which was palpated and heard as crackling. She had a shallow, upper thoracic stereotype with a lack of any involvement in the

abdomen. At the end, the patient was breathing independently, and had deeper, longer breaths. She implicated the abdomen and began using her whole thoracic region more. Additionally, she no longer exhibited signs of excess phlegm as no crackling was heard or palpated.

4 FINAL CONCLUSION

Working on this bachelor's thesis truly deepened my knowledge and appreciation towards liver transplantation. My respect has grown towards both the patients and all the healthcare professionals involved as liver transplants are a major surgery. It requires great skills by all the healthcare professionals to perform the operation and then care for the patient.

Researching this topic through the listed literature enriched me about livers and helped me understand the extent of their value in our organisms. However, physically attending IKEM and taking part in the process of rehabilitation truly expanded my interest and knowledge regarding this topic.

Working at IKEM was beyond a pleasure, it was an incredible experience that most students could dream to have. The staff were all incredibly formal, friendly and open, making a relaxed atmosphere. It was visible that everyone there truly cared about the patients and wanted to help them. This was especially noticeable in both my supervisors: Bc. Robert Charvát and Mgr. Daniela Sárazová.

I enjoyed working with my patient as she was always very willing and excited to exercise. According to my observations, her physical health significantly improved, I only hope that she felt the same. I wish her the best in the future and hope she will not counter any further complications.

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6 ANNEX

Annex 1 – Application of Approval by UK FTVS Ethics Committee

Annex 2 – Informed Consent Form

Annex 3 – List of Tables

Annex 4 – Table of Figures

Annex 1 – Application of Approval by UK FTVS Ethics Committee

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, 18/01/2022 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 Hrásky, 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: 105/2021
Date of approval: 18.1.2021

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

Annex 2 – Informed 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 výsledků vyšetření a průběhu terapie prováděné v rámci praxe 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: .....

Annex 3 – List of Tables

Annex 4 – Table of Figures