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Diagnosis of Chronic Venous Insufficiency and Automatic Ultrasound Therapy

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ABSTRACT

Technology has made people increasingly inactive, leading to a decrease in exercise and blood flow. This can cause varicose veins, which are swollen veins often found in the legs. They form when valves in the veins weaken and allow blood to pool. This condition, called Chronic Venous Insufficiency (CVI), causes symptoms like pain and poor blood flow. If these veins clot, it can lead to painful superficial thrombophlebitis. Data collected from surveys and sensors can help determine a person's activity levels and identify those at risk of developing varicose veins. We have developed a way to study varicose veins using sensors and an Arduino Uno board. The sensors track a person's body position, including standing, bending, and movement. The data is collected and analysed to create a personalized dataset. The Arduino board processes the temperature of the area around the veins. By monitoring temperature, we can learn more about the condition and how it affects blood flow. Through non-invasive ultrasound therapy, our project aims to improve blood flow and circulation, alleviating pain caused by varicose veins. This innovative approach provides an alternative to invasive procedures, offering patients a safe, convenient, cost-effective, and effective treatment option. The primary goal is to find a solution that enhances patient outcomes while minimizing discomfort and cost.

KEYWORDS: Varicose Veins, Blood Flow, Blood Clots, Sensors, Symptoms, Ultrasound.

1.INTRODUCTION

Varicose veins are enlarged, twisted veins that generally seem withinside the legs. They are mostly harmless, but some people may feel tired or achy around them. If they bleed or develop inflammation, they can lead to complications. Varicose veins that occur in the scrotum are called varicoceles, and those near the anus are called haemorrhoids. These veins can impact a person's physical, social, and emotional well-being. The exact cause of varicose veins is unknown, but risk factors include being overweight, not getting enough exercise, having a history of leg injuries, and having a family history of varicose veins. A research study was carried out from June 2009 to May 2011 at CG Hospital and Bapuji Hospital, which are affiliated with JJM Medical College in Davangere. Forty sufferers with signs of number one varicose veins had been covered withinside

the study. In this study, men had a higher incidence of varicose veins compared to women. Only 12.5% of the participants had a family history of varicose veins. The most common symptom reported by the patients was dilated veins, which affected 37 (92.5%) participants.

The second most common symptom was aching pain, affecting 22 (55%) participants. If the vein's walls become loose and lose their flexibility, the valves that prevent blood from flowing backwards may become weaker. These weakened valves allow blood to flow in the wrong direction, causing it to pool in the affected vein. This can result in swollen, enlarged veins, which can be caused by factors such as pregnancy, aging, constipation, tumours, or being overweight or obese. Veins are channels that transport blood depleted of oxygen from the body back to the heart and lungs. These veins have one-manner valves that save you blood from flowing backward. When these valves malfunction, the veins become swollen and enlarged, forming varicose veins. Varicose veins often develop in the legs and thighs. The increasing prevalence of desk jobs and prolonged sitting or standing due to modern technology advancements has contributed to the greater awareness of varicose veins. Research has explored non-invasive methods for treating this condition.

There are two types of varicose vein treatments: invasive and non-invasive. Invasive methods include laser therapy, sclerotherapy, radio frequency ablation, and ambulatory phlebectomy. Non-invasive options include whole body vibration, compression stockings, and exercise. Early detection and prevention of varicose veins is crucial because undetected veins can worsen and cause severe pain. In intense cases, surgical intervention can be necessary. Varicose veins are enlarged, swollen, and twisted veins that usually appear on the legs beneath the skin. They often cause discomfort but rarely pain. In severe cases, they can lead to inflammation (thrombophlebitis). When they occur near the scrotum, they are called varicoceles, and when they develop around the anus, they are called haemorrhoids. There is usually no specific underlying cause, but they are more likely to develop in people who stand for prolonged periods, such as teachers, nurses, and police officers. Prolonged inactivity and other factors can also contribute to their formation.

OBJECTIVE:

This project aims to create a system that can automatically diagnose and treat varicose veins without ongoing manual medical intervention. The system will use non-invasive techniques like ultrasound and infrared imaging to accurately diagnose varicose veins. It will include an automated compression device designed to adjust pressure based on the severity of the condition and the needs of the individual. The system will analyse collected data and adapt treatment accordingly. The effectiveness of the system in treating varicose veins will be tested and evaluated through trials.

METHODOLOGY:

To address the limitations of current varicose vein treatments, we propose a non-invasive method that eliminates the need for catheters or incisions. This technique significantly reduces procedure and recovery times. Energy-based therapies have proven effective in targeting tissues across the body for various therapeutic outcomes. To achieve the desired treatment effect, the target tissue temperature needs to reach at least 50ºC. We propose using ultrasound as the energy source for non-invasive varicose vein treatment. Ultrasound therapy offers two primary treatment approaches. Non-invasive methods exist for measuring arterial blood pressure, but venous blood pressure (VBP), which is essential for tracking fluid levels in the body, remains invasive and is primarily used in critical care settings. In our project, we designed a system centred around an Arduino UNO microcontroller, which serves as the system's "brain" and houses the software. This system employs a thermistor to measure body temperature, with two points of attachment to the patient's body.

2. RECENT WORKS

Techniques for treating varicose veins maintain to evolve, making removal much less invasive, much less painful, and greater green than ever. A recent study established a critical genetic risk score to predict the likelihood of patients requiring surgery for varicose veins. Genomic areas related to excessive chance covered the ones related to peak and obesity. Efforts by organizations like the Vascular Society of India and the Venous Association of India aim to promote research and study of venous diseases. Endo venous laser treatment (EVLT) and radiofrequency ablation (RFA):

These minimally invasive procedures use heat to seal off varicose veins, causing them to collapse and eventually disappear. Foam sclerotherapy is a foam solution is injected into the veins, causing them to scar and close. This treatment is often used for smaller varicose veins and spider veins. VenaSeal closure system is This procedure involves injecting a medical adhesive into the vein, sealing it shut. It's less painful than traditional vein stripping surgery and requires no downtime. Phlebectomy is Also known as micro phlebectomy, this procedure involves making tiny incisions to remove varicose veins close to the skin's surface. Compression stockings these are often recommended to improve circulation and reduce symptoms associated with varicose veins.

3. PROPOSED WORK EXPLANATION

The project focuses on developing technologies for monitoring and treating varicose veins. These technologies aim to provide a temporary solution that can help patients improve their blood circulation and restore normal blood flow in affected areas. Disease diagnosis involves non-invasive methods using sensors that measure values over time. Flex sensors detect knee bending, which restricts blood flow. Force sensors indicate whether the leg is stationary or moving, affecting pressure on leg veins.

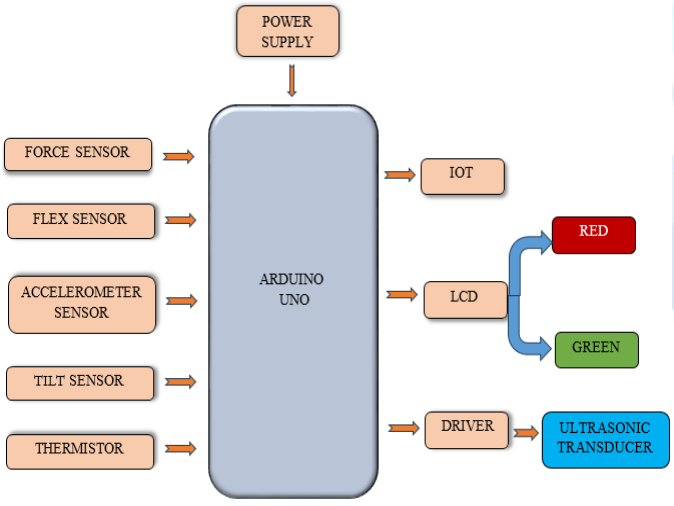

Figure 1: Proposed block diagram

Accelerometers contribute to determining the state of the leg. Non-invasive treatments avoid surgeries, resulting in swift procedures and rapid recovery. Wearable socks equipped with sensors monitor blood flow, temperature, and posture to detect potential issues leading to varicose veins. These sensors feed data to an Arduino UNO device, which employs for early diagnosis. Additionally, certain therapies utilize heat or other energy forms to treat body tissues, leading to therapeutic outcomes by achieving a desired temperature for effective treatment.

3.1 HARDWARE:

3.1.1 FORCE SENSOR:

Force Sensing Resistors (FSRs) are sensors that detect pressure. They consist of a round sensing area with a diameter of 0.5 inches. The harder you press on the sensing area, the lower the resistance of the resistor becomes. When no force is applied, the resistance is over 1MΩ. FSRs can detect forces ranging from 100g to 10kg. FSRs have two pins that extend from the bottom with a spacing of 0.1 inches, making them easy to use with breadboards. They also have a peel-and-stick rubber backing for easy mounting. While FSRs are easy to use and have good sensitivity, they are not very accurate and may not be suitable for applications where precise measurements are required, such as weighing objects. This force sensor is placed under the heel to know the person's various movements like standing, walking, continuous standing, and continuous sitting. The dataset is taken for decision making operation.

3.1.2 ACCELEROMETER:

The ADXL337 is a low power, small, thin complete 3-axis accelerometer having sign conditioned voltage outputs. The product measuring range acceleration with minimum full-scale range of ±3 g, also measures the static acceleration of gravity in tilt sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. Accelerometers allow users to customize their bandwidth by adjusting the capacitance values of CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. This feature enables users to tailor the accelerometer's performance to their specific needs. Bandwidths are selected to suit the application, with a range of 0.5 Hz to 1600 Hz for X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis. This sensor is a three-axis sensor giving values of X, Y and Z axes. In this non-invasive therapeutic treatment two accelerometer is used.

3.1.3 TILT SENSOR:

A tilt sensor is a device that measures the angle and direction an object is tilted when compared to the pull of the Earth's gravity. Typically, these sensors have a

conductive part (like a metal ball) in a housing with electrical contacts. When the sensor is tilted, the conductive part moves, creating or breaking contact to determine the tilt angle. Tilt sensors are used in different industries, including cars, robots, and airplanes, for tasks such as keeping things level, controlling stability, and detecting movement.

3.1.4 THERMISTOR:

Thermistors, a combination of "thermal" and "resistor," are highly sensitive resistors whose resistance changes significantly with temperature. They find applications in electronic circuits, such as inrush current limiters, temperature sensors (often utilizing negative temperature coefficient or NTC thermistors), self-resetting fuses, and self-regulating heating elements (often using positive temperature coefficient or PTC thermistors). The probe design dictates the operating temperature range for thermistors, typically between 212°F (100°C) and 572°F (300°C). Thermistors are categorized based on their material composition.

3.1.5 FLEX SENSOR:

Flex sensors are essentially bendable sensors designed with conductive components incorporated into a flexible material. These components exhibit a change in resistance when the sensor is bent, as the distance between them alters. This resistance variation enables flex sensors to detect bending or flexing motions, making them valuable components in various applications such as wearable technology, robotics, and medical devices.

3.1.6 ULTASONIC TREATMENT:

Ultrasound therapy can be used throughout the body for various treatments. For varicose veins, ultrasound offers a non-invasive treatment option known as non-thermal ultrasound therapy. This method involves applying ultrasound waves over the skin to disrupt tissue. The mechanical waves create acoustic beams that can damage the lining of the varicose veins without affecting surrounding tissues. Compared to other therapies, non-thermal ultrasound therapy is faster, more comfortable, and doesn't cause any side effects. It also reduces pain and delivers better cosmetic results without causing tissue damage.

4. RESULTS AND DISCUSSION

To address the inconvenience of current varicose vein treatments, a portable system has been designed. This system aims to provide cooling and compression therapy during leisure time, allowing individuals with varicose veins to continue their daily routines without interruption. The system incorporates several components, including an Arduino UNO microcontroller, an LCD display for user interface, an accelerometer for motion sensing, a thermistor for temperature measurement, a force sensor for pressure detection, a portable battery for power, a tilt sensor for detecting position changes, and a flex sensor for monitoring muscle movement. The Arduino UNO serves as the brain of the system, processing inputs from the various sensors and generating customized outputs based on the programmed algorithms. This enables the system to provide tailored ultrasound therapy based on the user's needs, helping to alleviate pain, reduce leg swelling, and improve blood flow for individuals with varicose veins.

Fig (a): Graphical output for temperature sensor

Fig (b): Graphical output for force sensor

5. CONCLUSIONS

This project introduces an innovative approach to detect varicose veins at an early stage, enabling timely preventive treatment. By continuously measuring temperature and pressure in the affected area, the system can identify when these parameters exceed set thresholds. When this occurs, the system activates ultrasound therapy to enhance blood flow and prevent

the formation of blood clots in the problematic area. The primary objective of this project is to leverage sensor data and Arduino UNO analysis to predict and prevent varicose veins, a condition caused by abnormal blood flow that leads to vein damage. Working closely with medical professionals, we developed a model that utilizes basic data to predict the onset of the disease. The system's sensors continuously monitor blood flow, while the body temperature, activated by a relay driver circuit, alternates between therapeutic modes to regulate blood flow and prevent the development of varicose veins. This approach aims to provide effective preventive care for individuals at risk of developing varicose veins, ultimately improving their quality of life.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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