ANKLE PUMP EXERCISE TRAINING DEVICE FOR PREVENTING DEEP VEIN THROMBOSIS OF THE LOWER EXTREMITIES

Field of the Invention

The present invention relates to the technical field of rehabilitation training devices, in particular to an ankle pump exercise training device for preventing deep vein thrombosis of the lower extremities.

Background to the Invention

Deep vein thrombosis (DVT) of the lower extremities is a common clinical vascular disorder, with a high incidence among postoperative patients, those who are bedridden for extended periods, or individuals with limited mobility. Ankle pump exercises, which involve repeated dorsiflexion and plantarflexion of the ankle joint to enhance venous return of the lower extremities, have been widely adopted as an effective rehabilitation technique to prevent DVT. However, conventional ankle pump exercise training devices exhibit several limitations in practical use.

Prior training devices generally lack precise motion monitoring mechanisms, making quantitative assessment of ankle dorsiflexion range difficult. During independent training, patients often receive no real-time feedback or reminders, resulting in limited awareness of whether target motion standards are consistently met. Inadequate training duration or failure to maintain proper form may compromise the preventive effect against complications. The absence of intelligent feedback also increases the supervision burden on medical staff, hindering the realization of efficient, self-directed rehabilitation. Most conventional devices remain focused on basic pressing or stepping functions and fail to establish a comprehensive closed-loop system encompassing “posture calibration, motion monitoring, and automated alerts”. During long-term rehabilitation, insufficient scientific guidance and feedback mechanisms may lead patients to gradually neglect proper technique, significantly reducing the effectiveness of DVT prevention of the lower extremities.

Statement of Invention

The present invention relates to an ankle pump exercise training device for preventing deep vein thrombosis of the lower extremities. The device addresses the deficiency in conventional training devices, which lack a precise motion monitoring mechan ism and thus fail to support quantitative assessment of whether the patient's ankle dorsiflexion range meets the required standard.

The invention provides an ankle pump exercise training device for preventing deep vein thrombosis of the lower extremities, comprising a base, wherein a side support block is fixedly mounted on the left and right sides of the top end surface of the base; a stepping block is disposed above the front side of the base, wherein the left and right end center portions of the stepping block are each fixedly provided with a rotating shaft, the two rotating shafts being rotatably connected to the two side support blocks via bearings; a rubber stepping pad is fixedly bonded to the front end surface of the base, wherein three sets of miniature vibration motors are evenly embedded within the rubber stepping pad; a pressure contact plate is disposed at the rear of the base, wherein a set of in-place monitoring switches is fixedly mounted at a central position of the top end surface of the pressure contact plate, the in-place monitoring switches being tactile switches with the key ends oriented upward; a control housing is disposed at the rear side of the top end surface of the base, the control housing being externally connected to a power supply and internally provided with a microcontroller, wherein the microcontroller is electrically connected to the miniature vibration motor and the in-place monitoring switch; and a start/stop switch is mounted on the top end surface of the control housing and is electrically connected to the microcontroller.

Further, a lifting plate is disposed beneath the pressure contact plate, with a mating plate fixedly mounted at a front-side portion of each of the left and right end faces of the lifting plate, each mating plate being provided with an insertion hole; the front end of the pressure contact plate is formed in a semicircular structure, and a stud is fixedly mounted on each of the left and right end faces of the pressure contact plate at positions corresponding to the axial center of the semicircular structure; the two studs are respectively inserted through the insertion holes of the mating plates and are threadably engaged with locking nuts.

Further, a lifting engagement post is fixedly mounted on each of the left and right sides of the bottom end surface of the lifting plate, and a lifting engagement slot is formed at the axial center of the bottom end surface of each lifting engagement post; a movable base plate is disposed below the lifting plate, and a lifting insertion post is fixedly mounted on each of the left and right sides of a top end surface of the movable base plate, wherein the two lifting insertion posts are slidably inserted into the respective lifting engagement slots.

Further, a locking engagement protruding post is fixedly mounted on an outer peripheral surface of each lifting engagement post adjacent to a lower side thereof, each locking engagement protruding post being provided, at its axial center, with a threaded locking through hole b that communicates with the corresponding lifting engagement slot; and a locking bolt b is threadably engaged in each threaded locking through hole b.

Further, the top end surface of the base is formed with two limiting slots, each having an isosceles trapezoidal groove structure and penetrating through both the front and rear end surfaces of the base; the bottom end surface of the movable base plate is fixedly provided with two limiting inserts, each having an isosceles trapezoidal block structure, and the two limiting inserts are slidably inserted into and engaged with the respective limiting slots.

Further, the central portion of the top end surface of the movable base plate is formed with a threaded locking through hole a extending through to the bottom surface, within which a locking bolt a is threadably mounted, such that in the locked state, the stud end of locking bolt a is in close contact with the top end surface of the base; wherein a countersunk through hole is respectively formed on both the left and right sides of the top end surface of the base.

Further, the interior of the control housing is further provided with a timing module electrically connected to a microcontroller; wherein the timing module is configured with a timing value of five seconds; when a in-place monitoring switch is pressed and activated, it transmits a signal to the microcontroller to trigger the timing module, and upon the timing value being reached, the timing module transmits a feedback signal to the microcontroller, which in turn controls activation of a miniature vibration motor.

The present invention provides an ankle pump exercise training device for preventing deep vein thrombosis of the lower extremities, which has the following beneficial effects:

The present invention achieves adjustment of the motion monitoring component via posture calibration by having the patient's foot soles contact a rubber stepping pad while performing ankle pump movements, during which a stepping block rotates along a side support block via a rotating shaft and bearing assembly allowing observation of ankle dorsiflexion range by a physician to assess movement compliance. Upon meeting the target movement criteria, a movable base plate is positionally adjusted by the sliding insertion fit between limiting inserts and limiting slots, and the base is locked by rotating a locking bolt a through a threaded locking through hole a, while a lifting plate height is adjusted via a sliding insertion fit between lifting insertion posts and lifting engagement slots and fixed by rotating a locking bolt b through a threaded locking through hole b; followed by angular adjustment of a pressure contact plate by rotating the plate via studs inserted into matching holes to ensure the plate is parallel to the rear end surface of the stepping block so that the key end of an in-place monitoring switch makes contact therewith; and then fixing the plate angle by locking nuts threaded onto the studs, thereby enabling full alignment and setup of the movement monitoring components for accurate detection of compliance;

During self-guided training, once the movement meets the target, the rear end surface of the stepping block presses against the key end of the in-place monitoring switch, triggering the switch to send a signal to the microcontroller. The microcontroller then activates a timing module, which starts counting. When the preset five-second threshold is reached, the timing module sends a feedback signal to the microcontroller, which then activates a miniature vibration motor to notify the patient that the movement is up to standard. Such a configuration enables a complete rehabilitation process - from posture calibration to motion monitoring and automated alerts - helping patients perform ankle pump exercises more accurately, improving the effectiveness and efficiency of rehabilitation, and reducing reliance on real-time supervision by physicians.

Brief Description of the Drawings

To illustrate the technical solutions of the embodiments of the present invention more clearly, the accompanying drawings are briefly described below.

The accompanying drawings described hereinafter relate to some embodiments of the present invention and are not intended to limit the scope of the invention.

In the drawings:

Figure 1 is a schematic front-end axonometric view of the present invention;

Figure 2 is a schematic rear-end axonometric view of the present invention;

Figure 3 is a schematic front elevation view of the present invention;

Figure 4 is a schematic exploded view of the stepping block of the present invention;

Figure 5 is a schematic top axonometric exploded view of the pressure contact plate of the present invention;

Figure 6 is an enlarged partial view of region A in Figure5;

Figure 7 is a schematic bottom axonometric exploded view of the pressure contact plate of the present invention;

Figure 8 is an enlarged partial view of region B in Figure 7;

Figure 9 is a block diagram illustrating the system components of the present invention.

List of Reference Numerals

1. Stepping Block; 101. Rubber Stepping Pad; 102. Rotating Shaft; 103. Miniature Vibration Motor; 2. Base; 201. Side Support Block; 202. Limiting Slot; 203. Countersunk Through Hole; 204. Control Housing; 205. Start/stop Switch; 206. Timing Module; 207. Microcontroller; 3. Pressure Contact Plate; 301. In-place Monitoring Switch; 302. Lifting Plate; 303. Movable Base Plate; 304. Limiting Insert; 305. Threaded Locking Through Hole a; 306. Lifting Insertion Post; 307. Locking Bolt a; 308. Stud; 309. Locking Nut; 3010. Mating Plate; 3011. Insertion Hole; 3012. Lifting Engagement Post; 3013. Lifting Engagement Slot; 3014. Locking Engagement Protruding Post; 3015. Threaded Locking Through Hole b; 3016. Locking Bolt b.

Detailed Description

To facilitate a clear understanding of the objectives, technical solutions, and advantages of the embodiments of the present invention, the technical solutions of the embodiments will be described below in detail with reference to the accompanying drawings. It should be understood that the described embodiments constitute only a part of the embodiments of the present invention, and are not intended to limit the scope thereof. Any other embodiments derived by a person skilled in the art based on the embodiments described herein, without involving inventive effort, shall fall within the protection scope of the present invention.

Embodiments: Reference is made to Figures 1 to 9.

The present invention discloses an ankle pump exercise training device for preventing deep vein thrombosis of the lower extremities, comprising: a base 2, wherein a side support block 201 is fixedly mounted on the left and right sides of the top end surface of the base 2; a stepping block 1 disposed above the front side of the base 2, wherein the left and right end center portions of the stepping block 1 are each fixedly provided with a rotating shaft 102, the two rotating shafts 102 being rotatably connected to the two side support blocks 201 via bearings; a rubber stepping pad 101 fixedly bonded to the front end surface of the base 2, wherein three sets of miniature vibration motors 103 are evenly embedded within the rubber stepping pad 101; a pressure contact plate 3 disposed at the rear of the base 2, the top central portion of which is fixedly equipped with a set of in-place monitoring switches 301, the in-place monitoring switch 301 being a tactile switch with the key end oriented upward; a control housing 204 disposed at the rear side of the top end surface of the base 2, the control housing 204 being externally connected to a power supply and internally provided with a microcontroller 207, wherein the microcontroller 207 is electrically connected to the miniature vibration motor 103 and the in-place monitoring switch 301; and a start/stop switch 205 is mounted on the top end surface of the control housing 204 and is electrically connected to the microcontroller 207; a lifting plate 302 arranged below the pressure contact plate 3, wherein the front side portions of the left and right ends of the lifting plate 302 are each fixedly provided with a mating plate 3010, each mating plate 3010 having an insertion hole 3011; the front end of the pressure contact plate 3 adopting a semicircular structure, with a stud 308 fixedly mounted on the left and right end faces relative to the axial center of the semicircular structure, the two studs 308 passing through the two insertion holes 3011 and each threadedly fitted with a locking nut 309; the bottom end surface of the lifting plate 302 being fixedly provided on both left and right sides with a pair of lifting engagement posts 3012, each lifting engagement post 3012 having a lifting engagement slot 3013 opened at the axial center of the bottom end surface; a movable base plate (303) arranged below the lifting plate (302), the top left and right sides of which are each fixedly provided with a lifting insertion post (306) that slidably engages with the lifting engagement slots 3013; the outer peripheral surfaces of the two lifting engagement posts 3012 adjacent to the lower sides each fixedly provided with a locking engagement protruding post 3014, each locking engagement protruding post 3014, at axial center, having a threaded locking through hole b 3015 communicated with the lifting engagement slot 3013, and each threaded locking through hole b 3015 being threadably engaged with a locking bolt b 3016.

The top end surface of the base 2 is provided with two limiting slots 202, each having an isosceles trapezoidal groove structure, the limiting slots 202 extending through the front and rear end surfaces of the base 2; the bottom end surface of the movable base plate 303 is fixedly provided with two limiting inserts 304, each having an isosceles trapezoidal block structure, the two limiting inserts 304 being respectively slidably engaged with the two limiting slots 202; a threaded locking through hole a 305 is formed through the center portion of the top end surface and bottom end surface of the movable base plate 303, a locking bolt a 307 being threadably engaged in the threaded locking through hole a 305, wherein in the locked state, the threaded stud end of the locking bolt a 307 is tightly abutted against the top end surface of the base 2; countersunk through holes 203 are formed on the left and right sides of the top end surface of the base 2; the control housing 204 is internally provided with a timing module 206 electrically connected to the microcontroller 207, the timing module 206 being preset with a timing value of five seconds. When the in-place monitoring switch 301 is pressed and activated, the switch 301 transmits a feedback signal to the microcontroller 207, which in turn activates the timing module 206; upon the timing module 206 reaching the preset timing value, the module 206 transmits a feedback signal to the microcontroller 207, which then controls the miniature vibration motors 103 to start operation.

The operating principle of the present embodiment is as follows:

The base 2 is positioned on a bed board and secured thereto by screws or other fasteners passing through countersunk through holes 203, thereby forming a stable supporting base.

Initial posture calibration:

A physician assists the patient in performing training exercises by having the patient place both soles firmly against the rubber stepping pad 101, then guiding the patient to perform ankle pump movements; when the patient's feet press against the rubber stepping pad 101 and extend forward, the stepping block 1 rotates rearward along the two side support blocks 201 via the rotational engagement of the rotating shafts 102 and bearings, allowing the physician to observe the amplitude of the patient’s ankle dorsiflexion and determine whether the movement complies with rehabilitation standards.

When the patient’s movement meets the required standard, the position of the movable base plate 303 is adjusted along the base 2 by sliding engagement between the limiting slots 202 and limiting inserts 304, and upon confirmation of position adjustment, a locking bolt a 307 is tightened via a tool along a threaded locking through hole a 305 such that the stud end of the locking bolt a 307 closely abuts the top end surface of the base 2, thereby securing the base 2. Subsequently, the height of the lifting plate 302 is adjusted by sliding insertion between the lifting insertion posts 306 and lifting engagement slots 3013, and once the height is fixed, a locking bolt b 3016 is tightened along a threaded locking through hole b 3015 such that its stud end abuts the lifting insertion post 306 to secure the lifting plate 302. Thereafter, the pressure contact plate 3 is rotated by engagement between insertion holes 3011 and studs 308 to align parallel with the rear end surface of the current stepping block 1, causing the key end of the in-place monitoring switch 301 to contact the rear surface of the stepping block 1, followed by tightening of a locking nut 309 along the stud 308 to secure the pressure contact plate 3 angle by abutting against the mating plate 3010; this arrangement facilitates patient self-training by enabling the key end of the in-place monitoring switch 301 to be pressed by the rear end surface of the stepping block 1 when movement is standard-compliant, thereby sending a signal to the microcontroller

207 to activate the timing module 206, which upon reaching a preset five-second interval, signals the microcontroller 207 to activate the miniature vibration motors 103, providing vibrational feedback to the patient as an indication of correct movement completion and thereby accomplishing an ankle pump exercise training cycle.