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Original Research

Designing the Magnetic Stationary Bike with Simultaneous Different Workloads for Each Foot

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ABSTRACT

The cycling exercise provides quadriceps rehabilitation while controlling the stresses to the knee ligaments. With pedaling on the bicycle, forces are applied to the anterior cruciate ligament, the capsular ligaments, and the posterior structures of the knee joint. The knee muscles can modify their forces. In most cases, one of the knees is damaged and undergoes surgery and rehabilitation. In such cases, the injured leg must be rehabilitated the use of bicycle workloads is limited to the tolerance range of the injured leg and the healthy leg must be trained in low workload. In elite athletes who have to come back to competition as fast as possible, this situation causes a loss of strength and fitness for healthy foot. The Magnetic Stationary Bike with simultaneous different workloads for each foot can create a condition for each leg to be trained simultaneously in its own workloads.

Keywords: Magnetic Stationary Bike, Knee Rehabilitation, Different Workloads

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INTRODUCTION

In the process of rehabilitating the knee after injury or surgery, the cycling exercise has proven to be a simple effective tool. It allows the individual to work on range of motion and strength (1). Cardiovascular conditioning by cycling exercise allows rehabilitation of the athlete's fitness. The regular ten-speed bicycle or the stationary bicycle can be used for cycling (2).

The bicycle provides quadriceps rehabilitation while controlling the stresses to the knee ligaments. With pedaling on the bicycle, forces are applied to the anterior cruciate ligament, the capsular ligaments, and the posterior structures of the knee joint as the tibial plateau is posteriorly tilted. The knee muscles can modify their forces. Therefore, by controlling the mode of cycling with varying seat heights and pedal positions, the ligaments can be relieved from these forces during the initial stages of the rehabilitative process. An exercise program can then be designed to apply controlled stress to these structures to enhance the healing and recovery processes (3, 4).

All of the major muscles of the legs are used at one point or another during cycling, but the major muscles that are used for generating power are the quadriceps group, especially the quadriceps muscle rectus femoris (Fig. 1). During the pedaling, the quadriceps mainly work as you push the pedal down and straighten your leg whilst the hamstrings at the back of thigh work to bend the knee (5). The amount of the hamstrings work varies - if you are using pedals where your feet go under a strap your hamstrings work more as you can use them to pull the pedal up using the strap (5, 6). By using cycling within the rehabilitation program the quadriceps can be strengthened whilst controlling the amount of stresses to the knee (3, 7) (Fig. 2).

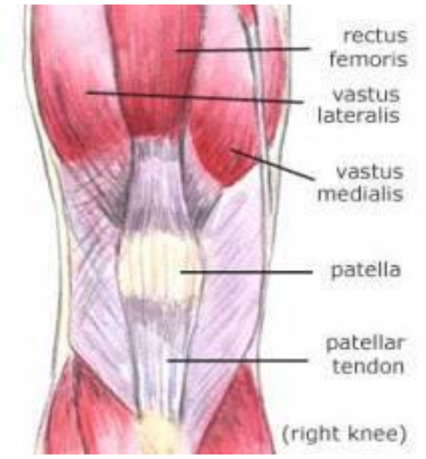

Figure 1. Quadriceps muscle

Knees like cyclical movement without excessive forces as that is the way that the articular cartilage covering the ends of your bones gets nourished (8, 9). Also, cycling has been shown to be a relatively safe activity for rehabilitation after anterior cruciate ligament (ACL) reconstruction as the strain that is placed on the ACL during cycling at rehabilitation levels is relatively low (10). Also, stationary cycling is typically recommended following total knee arthroplasty (TKA) operations (4).

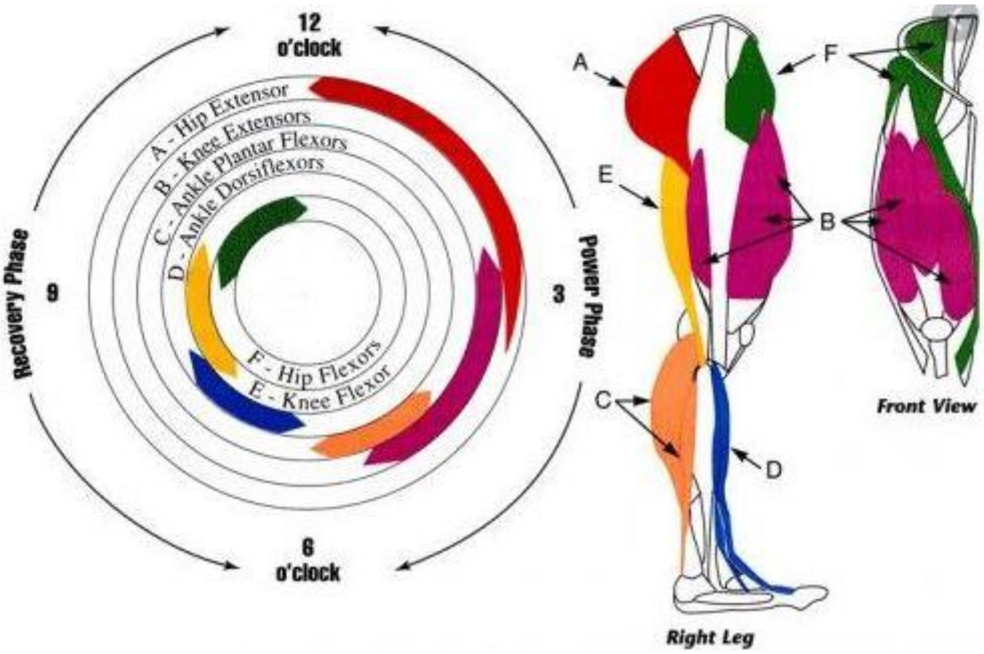

Figure 2. Leg Muscles Used in the Cycling Pedal Stroke

Knee injuries and rehabilitation are common among athletes (11). On the other hand, in elite athletes, faster recovery and in a shorter period of time, it is very important to return to competition (12). Accordingly, an athlete whose right leg has been injured during a rehabilitation using a stationary bike has to train his left leg in the same workload prescribed for his right leg (11). This will cause the healthy leg to lose its ability, strength and fitness over time. None of the stationary bikes available can solve this problem. They all apply the same resistance and load to both feet. Due to the fact that maintaining the fitness of a healthy limb is very important in parallel with the rehabilitation of injured limbs in athletes, it is necessary to design a stationary bike that train simultaneously each leg in its own workloads.

TECHNICAL FIELD OF INVENTION

The technical field of the invention is rehabilitation devices.

MATERIAL AND METHODS

The device is based on the pattern of stationary gym and therapeutic bikes, except that each of the left and right foot pedals has a separate set of wheels, chains and magnetic brake system (Fig. 3 and Fig. 4).

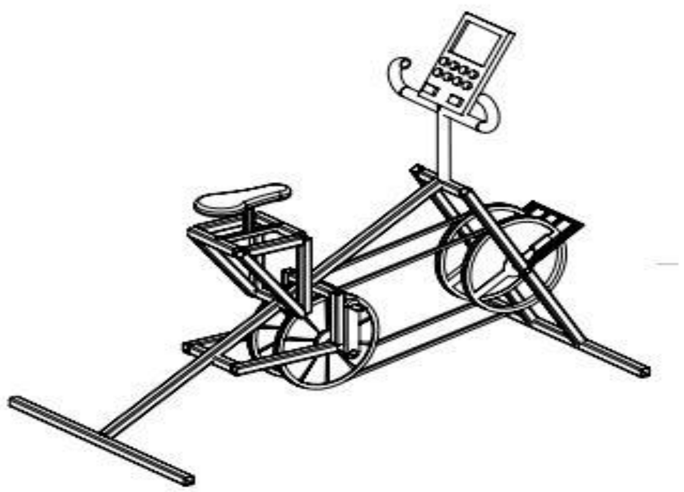

Figure 3. Overall look of Magnetic Stationary Bike with Simultaneous Different Workloads for each Foot

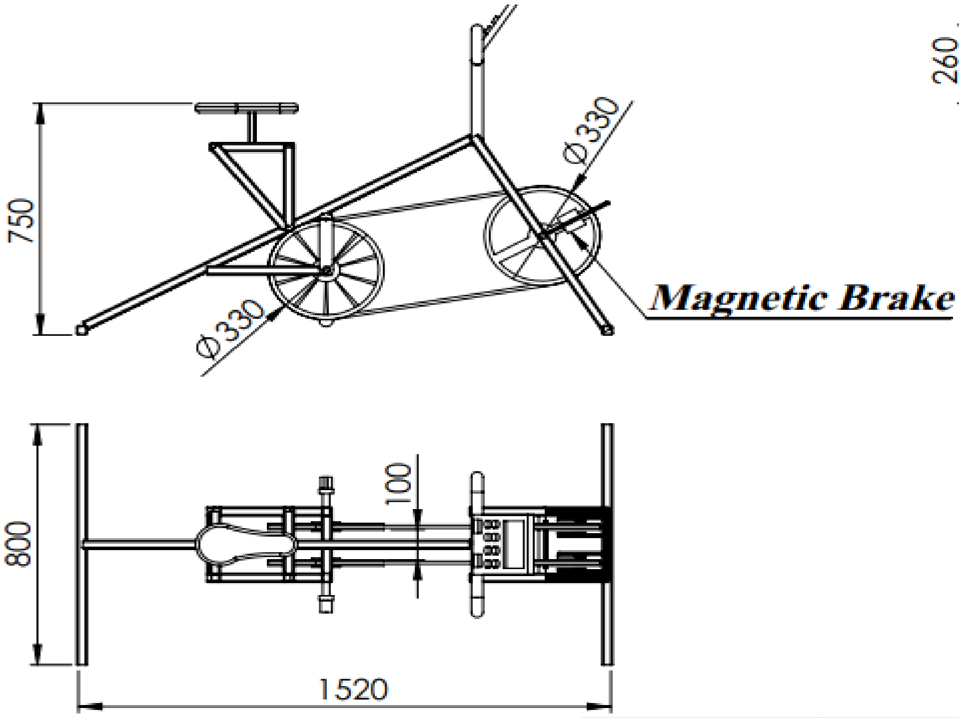

Figure 4. Location of the brakes and shows the dimensions of the pedals, wheels and the location of the brakes and symmetrical design of the wheels to apply different brakes on each of the pedals.

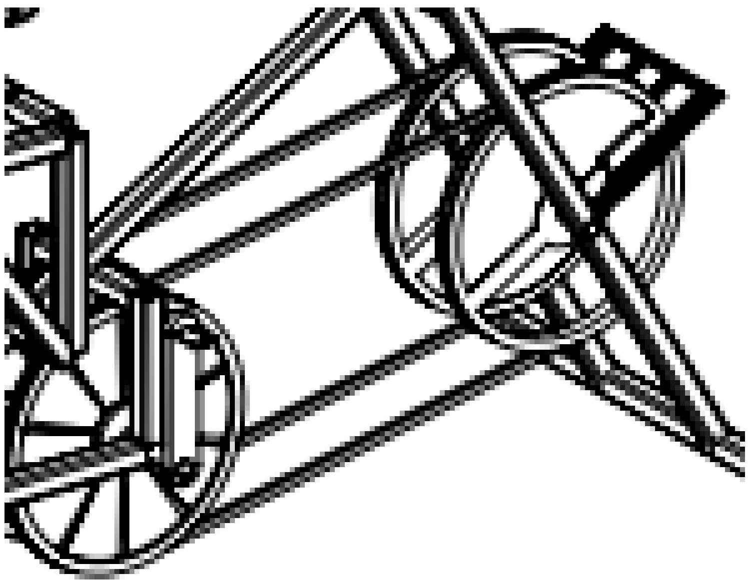

Figure 5. Design of the wheels

The circular plate of the wheel is cut from the middle to a semicircle so that half of the wheel is empty space (Fig 5). The empty space of the other wheel is opposite to the empty space of this wheel. On the other hand, there is a separate adjustable brake system for each wheel, which can be assigned a different magnetic resistance and load for each pedal. According to the pedaling period, half the circular path of the pedal is related to the application of the force of the right foot and the other half is related to the left foot. So each foot that exerts the force, the metal part of the wheel attached to the pedal of this foot is placed in front of the magnetic brake, and at the same time the empty part of the wheel corresponding to the other foot that does not exert force is placed in front of the brake. In this way, resistance is applied to the working foot and this cycle is repeated for the other foot in the same way.

FINDINGS

Claim 1: The interconnected pedal mode enables the device to allow the person to maintain the normal rhythm of the ride.

Claim 2: By adjusting the brakes on both the right and left wheels equally, the trainer can practice with equal load for both legs.

Claim 3: By adjusting the brakes separately for the right and left wheels, the person can ride with different loads simultaneously for each foot.

DISCUSSION

Post-operative muscle atrophy is a common sequela following orthopedic surgery and has a multitude of causes, including pre-operative diminished activity secondary to pain, the presence of inflammation, nutritional deficiencies, and limited muscle activation secondary to musculoskeletal injury (13, 14). The post-operative catabolic inflammatory state and subsequent immobilization and neuromuscular activation defects further contribute to post-operative muscle loss and residual strength impairment (15). For orthopedic procedures involving the knee, such as anterior cruciate ligament reconstruction (ACL-R), this process is significant because the loss of quadriceps muscle strength/size serves as a major barrier to post-operative physical rehabilitation and return to sport (16). The task of reducing post-operative quadriceps muscle atrophy and accelerating the return of quadriceps muscle strength seen in ACL-R patients has been studied in relation to multiple parameters, with increased focus on post-operative rehabilitation. For example, some physical rehabilitation protocols now incorporate electrical stimulation or immediate weight bearing with early removal of assisted walking devices as these measures are believed to accelerate return of muscle mass (17). However, despite these efforts patients continue to have reduced muscle strength and functional performance postoperatively (18). Therefore, further optimization in post-operative strategies targeting improved return to function in ACL-R patients is possible and warranted. Research has also been performed evaluating the addition of perioperative nutrition supplementation and its effects on postoperative muscle atrophy (19). The duration of recovery from sports injuries is a very important issue for all athletes, coaches and sports teams (20). In addition to the cost of a long recovery period, the points and sporting events that an athlete and team lose doubles the importance of a speedy recovery (21). In most sports injuries, the athlete has an injury in one of the legs (22). In such cases, after the injury, treatment of the injured leg begins and the healthy foot should be trained simultaneously. After the course of treatment, the recovery period of the injured leg begins. During this period, the focus of physiotherapists and sports coaches is on maintaining healthy foot preparation and increasing strength in the injured foot (23). The bicycle provides quadriceps rehabilitation while controlling the stresses to the knee ligaments. It is very common to use stationary bikes to rehabilitate athletes who have foot injuries or knee surgery. Due to the importance of maintaining healthy foot strength and rehabilitating the injured foot, a stationary bike that can apply special and different loads to each foot at the same time is required (24). Therefore, the design of Magnetic Bike with simultaneous different workloads for each foot allows physiotherapists, team technicians and athletes to achieve their goals in the rehabilitation period and return to training sessions and competition faster (25).

Conclusion

Rehabilitation tools play a very important role in the world of sports, so that sports teams are always looking for the latest rehabilitation devices for their clinics and clubs so that they can make the best use of their athletes in competitions.

Limitations

The conclusions presented in the present study are mainly based on the hypotheses and results of previous studies and the most obvious limitation of present study is lack of semi-experiments design. Thus, the actual efficiency of magnetic stationary bike with simultaneous different workloads for each foot in future studies should be evaluated by quasi-experimental research projects in different populations.

Acknowledgment
This device with patent number 89374, in the Office of Industrial Property, Center for Intellectual Property dated 2016 July 23, has been registered.

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چکیده فارسی

طراحی دوچرخه ثابت مغناطیسی با توانایی اعمال همزمان بارکاری متفاوت برای هر پا

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دوچرخه ضمن کنترل استرس در رباط‌های زانو، توانبخشی چهار سر ران را فراهم می‌کند. با پدال زدن روی دوچرخه، نیروهایی بر روی رباط صلیبی قدامی، رباط‌های کپسولی و ساختارهای خلفی مفصل زانو اعمال می‌شود. عضلات زانو می‌توانند نیروهای خود را تغییر دهند. در بیشتر موارد، یکی از زانوها آسیب دیده و تحت عمل جراحی و توانبخشی قرار می‌گیرد. در چنین مواردی، پای مصدوم باید بازتوانی گردد، استفاده از بارهای کاری دوچرخه محدود به تحمل پای مصدوم است و پای سالم باید در بارکاری کم تمرین داده شود. در ورزشکاران نخبه که باید هرچه سریع‌تر به رقابت بازگردند، این وضعیت باعث از بین رفتن قدرت و آمادگی جسمانی پای سالم می‌شود. دوچرخه ثابت مغناطیسی با توانایی اعمال همزمان بارکاری متفاوت برای هر پا می‌تواند شرایطی را ایجاد کند که هر پا به طور همزمان در بارهای کاری خود تمرین کند.

کلمات کلیدی: دوچرخه ثابت مغناطیسی، بازتوانی زانو، بارهای کاری مختلف.