The Use of Backward Running & Cycling as a Post-Operative Treatment Modality for the Rehabilitation of Various Knee Disorders

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Introduction

Traumatic injuries to the knee joint are common in all levels of sport, but there is considerable controversy regarding the implementation of appropriate rehabilitative modalities following surgery. The goal of knee rehabilitation is to increase the strength of the musculature that surround and stabilize the knee joint including the quadriceps, hamstrings, calves, gluteals, and muscles of the hip girdle. Over the years, sports medicine and allied health professionals have utilized a variety of rehabilitative modalities to increase the functional strength of the lower-extremity musculature to enhance "pain-free" mobility of the knee. Some of these modalities include, but are not limited to, proprioceptive/neuromuscular training using balance boards, low-intensity plyometrics, forward walking and running, graded walking, forward cycling, manual strength training, isokinetic training, and traditional strength training. Recently, there has been increasing interest in the use of backward walking, running and cycling as a

rehabilitation tool for traumatic knee injuries such as anterior cruciate ligament (ACL) tears and sprains, medial and lateral collateral ligament (MCL/LCL) sprains and tears, posterior cruciate ligament (PCL) sprains and tears, or patellofemoral pain (Flynn & Soutas-Little, 1993). In fact, backward cycling and walking to running progressions on a treadmill are becoming a popular, non-traditional component of function knee rehabilitation programs in the clinical setting (Cipriani, Armstrong, & Gaul, 1995; Flynn et al. 1993; Eisner, Bode, Nyland, & Caborn, 1999). The purpose of this paper is to investigate the current scientific research to determine whether backward running and cycling are effective modalities in the treatment of traumatic knee injuries among athletes and the general public.

Backward Cycling

In recent years, the utilization of backward cycling and walking to running progressions have been used in clinical settings to successfully rehabilitate traumatic knee injuries in athletes (Cipriani et al. 1995; Flynn et al. 1993; Eisner et al. 1999). Researchers hypothesize that cycling backward on a cycle ergometer increases muscle fiber activation of the lower-extremity musculature improving strength. Consequently, researchers are investigating the efficacy of backward cycling as an effective rehabilitative tool following surgery in athletes with serious knee injuries. In a study that compared the degree of muscle fiber activation of the vastus medialis, vastus lateralis, rectus femoris, medial hamstrings, lateral hamstring, tibialis anterior, and the gastrocnemius muscles during forward and backward cycling in twelve healthy subjects (6 male, 6 female), Eisner et al. (1999) hypothesized that the latter would demonstrate greater activation while backward cycling. During the electromyographic (EMG) and

motion analysis, the researchers observed that the medial and lateral hamstring activation duration was greater during the early recovery phase of backward cycling than forward cycling and the rectus femoris activation duration was greater in the early propulsive phase of backward cycling and in the early recovery phase of forward cycling. Current literature suggests that the implementation of backward cycling during the early post-operative stage of knee rehabilitation programs has proven to be effective in improving knee strength and stability (Eisner et al. 1999; Neptune & Kautz, 2000). More specifically, backward cycling allows for increased hamstring activation which generates reduced patellofemoral stress and anterior cruciate ligament strain. The EMG and motion analysis data presented by Eisner and his colleagues lend support for the use of backward cycling as an effective rehabilitation tool in treating athletes with serious knee injuries.

Strengthening the hamstring muscles is imperative for protecting the knee joint against traumatic injuries such as ACL, MCL, LCL, PCL sprains and tears, or patellofemoral pain. According to Esiner et al. (1999), backward pedaling on a stationary cycle ergometer generates increased hamstring activation duration and therefore provides greater increases in strength providing a basis for varying pedaling direction during rehabilitation programs. Thus, they concluded that backward pedaling is an effective alternative to forward walking and running, or other treatment modality for knee rehabilitation, especially for ACL injuries and patellofemoral pain. Neptune et al. (2000) demonstrated similar findings in a study that examined forward dynamic simulations of forward and backward pedaling in order to determine whether backward pedaling is advantageous over forward pedaling in rehabilitating common knee disorders. Using a musculoskeletal model and optimization framework to generate simulations of forward and backward pedaling, Neptune and his colleagues discovered

that lower tibiofemoral compressive loads, but higher patellofemoral compressive loads, were generated in backward pedaling. Moreover, lower protective anterior-posterior shearing forces were produced in backward pedaling near peak extension, which indicates excessive force being placed on the ACL. Based on this information, the researchers concluded that backward pedaling is not a viable treatment modality for athletes with patellofemoral pain due to the higher patellofemoral compressive forces. They also indicate that backward pedaling is contraindicative for athletes with an injury to their ACL due to the fact that very little anterior-posterior protection was offered near peak extension during backward pedaling. However, backward pedaling is a good alternative for athletes with menisci damage and osteoarthritis.

Backward pedaling may not provide a rehabilitative advantage over forward pedaling (Neptune et al. 2000). Recent research has also shown that there is no difference in hamstring activation duration and power output between backward or forward cycling, contradicting the conclusions established by Esiner and his colleagues (Neptune et al. 2000).

Backward Walking & Running

Similar to backward pedaling, backward walking and running progressions are becoming more popular among sport medicine specialists as a treatment resource for various knee injuries. Moreover, backward walking to running progressions are also primarily used only in clinical settings on high performance treadmills that can elevate to a 40% grade. Despite the recent emergence of backward walking and running as a rehabilitation tool, backward walking and running as an effective knee injury treatment tool has been the focus of many research projects. Researchers are interested in determining whether backward walking and running, either flat or at an incline, is effective in rehabilitating common knee injuries compared to forward walking and

running. For example, in a study that evaluated the adaptations in the gait cycle produced by walking backwards on a graded treadmill (0, 5, & 10% inclination), Cipriani et al. (1995) hypothesized that backward walking up an incline places greater stress on the lower-extremity muscles leading to greater strength improvements compared to forward walking. Current literature indicates that knee rehabilitation that emphasizes improving functional strength is more effective in successfully treating common knee ailments (Cipriani et al. 1995; Flynn et al. 1993; Neptune et al. 2000). In this study, joint positions of the hip, knee, and ankle were measured during the complete gait cycle (swing and stance phase). The researchers demonstrated that significant changes occurred in the joint positions of the knee (30.94 +/- 5.25 degrees to 42.42 +/- 4.08 degrees) and ankle (9.81 +/- 5.06 degrees to 13.08 +/- 3.68 degrees) (increased plantar-flexion) at foot-strike as the treadmill was raised from 0% to 10% grade. The researchers also demonstrated that significant changes occurred in EMG activity for each muscle studied over the three treadmill slopes. The greatest change occurred in the gastrocnemius muscle at foot-strike (189.76 +/- 44.29% to 293.09 +/- 79.16%) between 0% and 10% grade. Based on this information, the researchers concluded that incline backward walking places greater muscular loads on the muscles of the lower extremity resulting in greater improvements in functional strength.

Backward running has been suggested has a treatment modality for patellofemoral pain syndrome (Flynn & Soutas-Little, 1995; Flynn et al. 1993). Currently, very little research has been conducted to evaluate the effectiveness of backward running and walking relative to the forces it produces at the patellofemoral joint. In an attempt to measure the loads produced by backward running on the patellofemoral joint, Flynn et al. (1995) collected ground reaction forces and kinematic data for five male runners during free forward sprinting and backward running. The

results of the study lend support to the conclusions already established in the literature. Backward running produced significantly lower patellofemoral compression forces than forward running. The conclusions established by the researchers support the hypothesis that backward running in addition to quadriceps strengthening, may be beneficial in the rehabilitation of patellofemoral pain syndrome in athletes that compete in sports that involve running.

Backward walking, running, and pedaling may be beneficial in treating lower-extremity injuries other than those associated with the knee (Bates, 2000) According to Bates (2000), backward running may also be helpful in the following rehabilitation situations:

1. back rehabilitation (backward running allows for better trunk posture than forward running, for example);
2. recovery and strengthening from hip joint injuries;
3. recovery from groin injuries;
4. recovery from hamstring injuries;
5. alleviation of shin splint syndrome (anterior compartment syndrome);
6. recovery from Achilles tendon injuries;
7. recovery from ankle joint sprains.

Conclusion

Backward pedaling on a stationary egometer and backward walking and running on a treadmill have been used in rehabilitation programs for a variety of knee ailments such as ACL, PCL, MCL, LCL, or patellofemoral pain with success. There is a substantial amount of anecdotal evidence available to support the hypothesis that backward running, walking, and cycling increase muscular loads on the muscles of the lower-extremities resulting in greater improvements in strength. In addition, the research also

indicates that backward motion also results in lower compression forces generated at the patellofemoral joint making backward running a viable alternative to forward running or other forms of rehabilitation. Based on this evidence, sports medicine and allied health professionals are implementing backward movements into their lower-extremity rehabilitative programs at an increasing rate. However, there is also scientific evidence that contradicts the use of backward movements as a treatment modality for the knee joint. Some researchers agree that backward running, for example, is only warranted in the rehabilitation and treatment of osteoarthritis and menisci damage. Therefore, more research is necessary to solidify or negate its place in rehabilitation settings.

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