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Effects of the Latest Robotic Horse-riding for Low Back Pain : Narrative Review

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Abstract

Purpose: The purpose of this study is to review health-care program using the recent robotic horse-riding technology and its clinical effects for chronic low back pain. **Research design, data and methodology:** Recent clinical articles were determined under three inclusion criteria for in-depth review: 1) article that is published within 1 year, 2) article that includes the detailed explanation of health-care program using robotic horse-riding, 3) the article that deals with chronic low back pain during more than 6 months. **Results:** As a result, the finally-determined two articles demonstrated the clinical effects of robotic horse-riding statistically on pain intensity, low back muscle strength, spinal alignment, and fear-avoidance belief. **Conclusions:** After in-depth review, I concluded that health-care program using robotic horse-riding for chronic low back pain needs to be provided at low-intensity (e.g. less than 6km/h horse walking program) in the beginning of health-care for improving their motor control ability, then, at the increased intensity for strengthening core muscles.

Keywords : Core exercise, Health Care, Nonspecific low back pain, Patient well-being, Robotic horse-riding

JEL Classification Codes : I10, I30, I31

1. Introduction

Low back pain (LBP) is one of representative musculoskeletal disorders, reported that 90% of adults experience at some time in life and 80% of LBP are diagnosed as nonspecific low back pain (NSLBP) (Meucci et al., 2015). Furthermore, more than half of NSLBP develops into more than 1-year chronic low back pain that burdens health-care costs highly (Parthan et al., 2006). Therefore, the emphases to care NSLBP effectively have been suggested to reduce the pain in early stages and prevent chronicity with various conservative pain care methods (Searle et al., 2015).

A common principle of pain care methods, suggested in many previous studies so far, is to activate para-spinal muscles and acquire the stability of body trunk and lower extremity (Cooper et al., 2016). Especially, patients with chronic LBP were characterized by the loss of motor control in pelvic and lumbar site due to persistent pain (Dankaerts et al., 2006). That is why, recently, horse-riding has been suddenly received attention to treat LBP using horse's four-feet gait. Some studies reported that horse's four-feet gait induced natural pelvic movement of riders to activate the spinal muscles and improve ultimately their motor control by transmitting horse's repetitive and symmetrically rhythmic movement to human's pelvic (Stergiou, 2017). According to previous studies, these horse's movement showed therapeutic effects on muscle activation, core muscle strength and even emotional state improvement for riders (Håkanson et al., 2009; Kim & Lee, 2015). However, real horse-riding has still critical limitations to use for health-care such as a high cost, low accessibility, and risk of falling etc.

Robotic horse-riding system, imitating real horse movement has developed to utilize merits of real horse-riding and supplement its limitations. After then, studies reported similar effects of robotic horse-rising system on various musculoskeletal diseases, including chronic low back pain (Park et al., 2014; Kim et al., 2016). However, all robotic horse-riding studies individually used different exercise protocols and outcome measurements for chronic LBP and no studies suggested an apparent guideline.

Therefore, in this study, in-depth review of articles that studied on the clinical effects of the latest robotic horse-riding technology for chronic LBP was conducted and proposed a standardized pain care method.

2. Methods

2.1. Literature Search and Collection

Scopus, RISS, Google Scholar database were used to search literature that studied on the clinical effects of robotic horse-riding for LBP. Search keywords were "simulated horse-riding", "robotic horse-riding", "chronic low back pain" and combined finally to one sentence like (simulated horse-riding OR robotic horse-riding) AND "low back pain".

After searching, article was excluded preferentially before conducting in-depth review in case that 1) article was not relevant with robotic horse-riding, 2) article was not an experimental study and 3) article was not written in English.

2.2. Inclusion Criteria for Literature Selection

After conducting search and data collection, articles were finally determined to review according to three inclusion criteria as follows:

1) Articles were published within recent 3 years

2) Articles included the detailed explanation of health-care program using robotic horse-riding

3) Articles dealt with more than 6-month chronic low back pain

3. Results

3.1. Literature Final Selection for In-depth Review

A total of 93 articles was searched through three databases except for duplicates. After screening to correspond to inclusion criteria, three articles to meet the criteria were finally included for in-depth review (Figure 1).

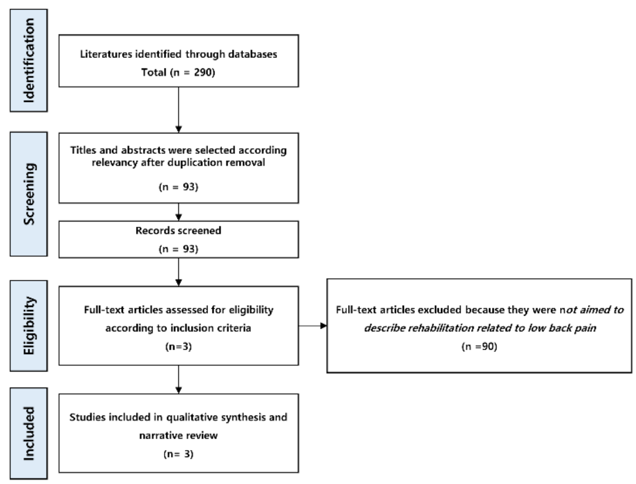

Figure 1: Literature Selection

3.2. Exercise Protocol Using Robotic Horse-riding (RHR)

First, Rahbar et al. (2018) provided RHR to 40 middle-aged adults with chronic LBP suffering for 7.05±1.74 months. The RHR exercise was performed 15 min/session everyday during 15 days. The exercise protocol was consisted of surface heat, deep heat, and transcutaneous electrical nerve stimulation and 15-min RHR exercise with preparatory mode, which was provided at hardware. Unlike other two articles, this article did not describe the hardware function of robotic horse in detail.

Second, Park et al. (2020) provided RHR to forty older people with chronic LBP, suffering for 23.61±8.47 months. The RHR exercise was performed for 30 min/session of 3 sessions/week during 12 weeks. The exercise protocol was consisted of 8-min warm up, 15-min work out, 7-min cool down.

Functions of RHR hardware were classified to 4 stages according to real-horse gait pattern such as walking, trotting, cantering, and galloping. In the beginning of exercise, they used walking function (3km/h~6km/h) for allowing participants to adapt the robotic horse motion. Then, the speed of motion was increased to 15km/h~24km/h, which called trotting and cantering function. They did not use galloping function (~60km/h) to prevent from lumbar shock.

Lastly, Kim et al. (2020) provided RHR to 16 young adults with chronic LBP, suffering for 58.22±37.37 months. The RHR exercise was performed for 30min/session of 2 session/week during 8 weeks. The protocol was consisted for 5-min warm up, 20-min work out, 5-min cool down. The function of RHR hardware was identical with Park et al. (2020) like walking, trotting, cantering, galloping. They used only two hardware function: walking and trotting. The speed was 4.8km/h in walking and 8.1km/h to 9.5km/h in trotting function.

3.3. Therapeutic Effect of RHR Exercise

Outcome measurements to prove the clinical effects of RHR was different in all studies. First, Rahbar et al. (2018) reported significant improvement in Visual Analog Scale (VAS) for pain intensity (P.<001), Roland Morris Disability Questionnaire (RMDQ) for physical disability (P.<001), and Modified Schober test for lumbar mobility function (P.<001). In Park et al. (2020), they also found the clinical effects in VAS (P<.001), Oswestry Disability Index (ODI) (P<.001) for physical disability, 30°/s isokinetic trunk extensor strength (P=.002), 60°/s isokinetic trunk extensor strength (P=.036), 120°/s isokinetic trunk extensor (P.<001) and flexor strength (P.<001), body fat (P.=009), lumbar lordotic curve angle (P.<001) and kyphotic curve angle (P.=017). Lastly, In Kim et al. (2020), they found the clinical effects in Numeric Rating Scale (NRS) for pain intensity, ODI, RMDQ, Fear-Avoidance Beliefs Questionnaire (FABQ) for pain-related psychological states (all P.<001).

4. Discussion

Patients with chronic LBP instinctively minimize their movement to reduce pain with psychological fear. This nature and reflexive behavior cause the disuse atrophy of spinal muscles, the loss of motor control and the instability of lumbar region which all symptoms ultimately lead to deteriorate the vicious cycle of pain. Therefore, many pain-care methods have been suggested to cut off the pain cycle by improving the mobility and stability of spine.

In recent years, robotic horse-riding (RHR) that mimic real horse movement has been introduced as an exercise device to strengthen core muscles and applied for various diseases. In this study, the exercise protocols and therapeutic effects of RHR, proved in three studies were reviewed and its feasibility was identified.

Especially, the effects of RHR exercise for chronic LBP were comprehensive to care the chronic pain from physical state measured by VAS, NRS to psychological state measured by FABQ. As many studies reported the positive effects of real horse-riding for health-care of patients in the past, the robotic horse-riding to imitate elaborately the real horse movements (like walking, trotting, cantering, galloping) also showed the similar positive effects on chronic pain. Furthermore, an inherent merit of robot such as manipulation tailoring user's request was also identified.

After in-depth review, I found a common application methodology in three studies that all exercise protocol using RHR was performed at lower intensity than expectation. In other words, in case that a user wants to use RHR with purpose of pain-care rather than fitness or recreation, low-intensity exercise (less than 6km/h walking mode) would be enough to experience the pain reduction effects. Also, walking mode would be easier to follow the robot's motion for improving the mobility of pelvic and spine than other mode.

Then, the increased speed of 15km/h~24km/h in trotting function would be helpful to strengthen core muscles. This recommendation is also supported by the general rehabilitation methodology that prioritize pain relief and motor control recovery before strengthening tissues. On the other hand, in case that a user wants to increase the body fitness and enjoy the recreation with game, more than 24km/h cantering and galloping mode would be recommended. Recently, with the development of virtual reality (VR) technology, various games using VR and RHR has been launched for recreation.

However, in the process of this study, I found that relatively fewer studies of RHR were conducted in fitness and recreation field as well as medical field. Therefore, based on this feasibility of RHR technology which used for all users with or without disease, future studies are necessary to be conducted consistently for proving its potentiality.

5. Conclusion

In this study, three previous studies which dealt with the clinical effects of the latest robotic horse-riding (RHR) system on chronic low back pain, were reviewed in depth and appropriate use guideline was proposed. Three studies were commonly reported differentiated exercise methods according to purpose of utilization (i.e., pain-care, exercise for health promotion, and recreation). In conclusion, for a user utilizing RHR with a purpose of pain-care, low intensity RHR exercise (less than 6 km/h) would be recommended to improve the mobility of pelvic and spine structure in the beginning and moderate intensity (15~24 km/h) for soft tissue strengthening.

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