ISSN: 2586-7342 © 2021 KODISA & KJFHC
KJFHC website: http://www.kjfhc.or.kr
doi: http://dx.doi.org/10.13106/kjfhc.2021.vol7.no3.25.

Change reaction of fatigue recovery material before and after taping during isokinetic exercise[1]

[1]Seung-Chul CHOI, [2]Sang-Ho LEE, [3]Jun-Su KIM

1. First Author Dept. Sport Tourism Convergence Eulji University, Korea, E-mail: csc75@paran.com
2. Corresponding Author Dep, health management Jaeneung University, Korea, E-mail: sm520627@naver.com
3. Corresponding Author Dept, Outdoor Sports Eulji University, Korea, E-mail: kim2019@eulji.ac.kr

Received: April 26, 2021. Revised: May 24, 2021. Accepted: June 05, 2021.

Abstract

This study examined the effects of kinesio taping on recovery from fatigue induced by an exercise of concentric contraction using an isokinetic machine. The fatigue was introduced by a mode of exercise at 60°/sec, 50 repetitions for three sessions. The changes of blood ammonia, lactate, LDH, and CK as a marker of fatigue were monitored. Eight healthy collegiate students participated in two experiments; 1) kinesio taping application condition and 2) no kinesio taping application condition. Before experiments, their physical characteristics were measured. For the experiment, blood samples were taken before and immediately after exercise, and 24hr as well as 72hr of recovery period. Window SPSS package 12.0 version was used and one-way ANOVA with repeated measures were employed. The results were as follows. 1) Blood ammonia tended to reduce along the recovery, but no differences between conditions were noticed. 2) Blood lactate tended to reduce during the recovery period, but differences between conditions were not noticed. 3) The LDH was not different between conditions and CK tended to reduce during the recovery period, but differences between conditions were not noticed. Based on the results, kinesio taping did not influence on recovery phase of blood ammonia, lactate concentration, LDH, and CK.

Keywords: Kinesio taping, Ammonia, Lactate, LDH, Ck

Major classifications: Health Science

---

1. Introduction

Sports taping is a representative non-invasive method that helps maintain and improve muscle function during physical activity by attaching adhesive tape directly to the surface of the human body, and it can be said to be a representative non-invasive method that exhibits a therapeutic effect as well as a convenient method of use (Clark & Lucett, 2010). The application of sports tape is suggested as an alternative to wrist joint protection equipment. As positive research results on the effect of sports taping have been reported, it is widely used by professional sports players, amateurs, and general sports

1 This work is supported by Eulji University in 2021.

enthusiasts. It is reported that the sports taping effect limits joint movement, limits joint stability and excessive movement, and helps reduce joint pain (Abián-Vicén et al., 2009; Kim et al., 2020). Most taping application effects are the result of short-term application. Due to this effect, it is commonly used in the course of sports rehabilitation or for the purpose of preventing re-injury after rehabilitation. Two types of sports tapes having inelastic and elastic properties are commonly used in the sports field.

In a domestic study of the effects in Aerobic/anaerobic muscle activity, the application of kinesio taping therapy can reduce the increase in blood lactic acid concentration of the exercise fatigue substance and was found to be effective in the muscle fatigue (Csapo, & Alegre, 2015). In addition, taping is used for the flexors and extensors of the lower limbs and knee joints. In addition, it was reported that there was a decrease in muscle strength and muscle fatigue in the extension muscle strength of the lumbar region and the function of the ankle joint.

There are three types of energy metabolism used in muscle contraction: the ATP-PC system by creatine phosphate and the use of oxygen in ATP synthesis/Depending on the radish, it is divided into an anaerobic glycolysis process and an aerobic glycolysis process. Of these, lactic acid is produced as a final by-product in the anaerobic glycolysis process and accumulates in the muscles and blood, causing muscle fatigue (Shulman, & Rothman, 2001).

Fatigue can be defined as an increase in the concentration of metabolic by-products due to prolonged exercise or continuous stimulation, or a decrease in body response or functional ability due to depletion of energy supply. In prolonged muscle exercise, waste products such as lactic acid are accumulated due to chemical changes in the muscle, and when glycogen and ATP are depleted, the contractile force of the muscle fibers decreases, resulting in fatigue (Edwards, 1981).

Lactic acid, known as a representative substance causing fatigue, is a substance formed by anoxic glycolysis. It is formed by an oxygen fan during exercise and is known as an index of fatigue substances during exercise (Gladden, 1996). In addition, lactic acid, ammonia, and lactate dehydrogenase (LDH), which are fatigue-causing substances that have an important effect on exercise fatigue, are indexes of physiological exercise capacity and fatigue pattern analysis based on energy metabolism (Costill et al, 1983). Removing these substances that cause fatigue is called fatigue recovery. In Korea, Munpoongji (Hanji) was used as a folk remedy to cover the pain area. This can be seen as the beginning of taping to relax muscles. Taping therapy is used for professional athletes to show strong athletic ability and to prevent sports injuries. In addition, taping therapy is regarded as a treatment for acute or chronic musculoskeletal pain in the general population without any side effects that may be of particular concern (Jeong, & Kim, 2010).

Kinesio taping therapy uses the principle of muscle homeostasis by attaching an adhesive tape that has not been treated with drugs to the muscles of the human body. It is a natural remedy that normalizes muscle weakness, muscle spasms, tension, and improves circulation of blood, tissue fluid, and lymphatic fluid to balance the muscles that are not in harmony with the surroundings, improving symptoms and controlling pain (Kaya, Zinnuroglu, & Tugcu, 2011).

It is widely known as a conservative treatment method for relieving pain in the musculoskeletal system and recovering muscle strength and function as a therapy to correct the imbalance of tension and relaxation of muscles and ligaments by attaching tape to a specific part of the human body (Garcıa-Muro, Rodrıguez-Fernandez, & Herrero-de-Lucas, 2010).

However, although the usefulness of taping treatment results has been experienced in clinical and sports fields, the mechanism of action for taping is still controversial, and academic approaches to the theoretical basis are not enough.

There is controversy about its value in the medical field, and most of the studies so far have been limited to studies on the effect of taping on muscle expression and protection of the musculoskeletal system, so a more objective study is urgent (Zanca, Mattiello, & Karduna, 2015).

In muscle contraction activities that artificially cause muscle fatigue, extensible contractions cause more fatigue than uniaxial contractions. Muscle fatigue lacks intense eccentric contraction activity, muscle pain and flexibility. This is to be generated from the reduction of muscle strength through long-term exercise (Armstrong, 1990; Ebbeling, & Clarkson, 1989). It is reported that reason of the artificial muscle fatigue due to eccentric muscle contraction activity is related to the high load ratio of muscle tissue (Enoka, 1996). At the same time, muscle fatigue reduces the range of motion of the joints, increases muscle expansion, perimeter and volume as well (Fridén, Seger, & Ekblom, 1988) But the force exercised during the extension of the muscle and flection decreases (Miles, & Clarkson, 1994). It is also reported that the range of motion (ROM) of the joints is also less than the pre-exercise condition in the case of artificial muscle fatigue-causing exercise (Cleak & Eston, 1992). Rehabilitation technology is a way to improve the quality of life, improve the range of exercise, and reduce pain in patients with knee osteoarthritis. The relationship of torque-velocity between muscle renal contraction and shortening contraction is reported that the torque at maximum renal contraction is generally greater than at maximum shortening compared in the range of joint movements (Doss & Karpovich, 1965) and motor speed (Asmussen, Hansen, & Lammert, 1965; Viitasalo, & Komi, 1977). Therefore, this study attempts to analyze the fatigue recovery effect of Kinesio taping method by observing changes in blood ammonia, lactic acid, LDH, and CK after inducing maximum artificial muscle fatigue through shortening muscle contraction with constant motion.

2. Research method

2.1. Participants

Eight men in the Department of Physical Education at D University in Gyeonggi-do Province were selected for the study, who were healthy without specific diseases, fully understood the purpose and procedures of the experiment, and voluntarily expressed their willingness to participate in the experiment. The characteristics of the experimenter participating in this experiment are shown in Table 1.

Table 1: Subject's physical characteristics M±SD

N	age (yr)	kidney (cm)	weight (kg)	BMII (kg/m2)	skeleton Muscle mass (kg)	restraint Quantity (kg)
8	21.6 ± 1.60	174.1 ± 6.92	70.89 ± 14.0	21.33 ± 1.69	33.0 ± 5.90	57.89 ± 8.72

2.2. Research procedure

The experiment of this study was conducted in the exercise prescription laboratory of D University located in Gyeonggi-do, and the experimental design to achieve the purpose of this study is as follows.

2.2.1. Experimental method

In order to exclude the fatigue factors, we fully explained the overall contents and precautions before the test, asking participants to refrain from drinking or excessive exercise for 2 days before the experiment, measured the body composition of 8 subjects two hours before the test using a body composition analyzer, and collected blood in a stable condition from 4 participants who will be applying Kinesio taping.

This experiment was conducted two times, with/without the application of Kinesio taping, and in the first test, we divided subjects into two groups (4 with Kinesio taping, 4 without).

Blood was collected during the measurement period (right after exercise, 24 hours after exercise, and 72 hours after exercise), and the Kinesio taping group was controlled to prohibit drinking or excessive exercise.

Two weeks later, in order to reduce the error, four of the second test equivalents were cross allocated to another group and four were tested in the same way as the first experiment

2.2.2. Exercise method

Using a Isokinetic device (Cybex 770), the exercise of the lower extremities centered on the slant joints was designed to exert maximum flexion and strength through pre-experimentation and training to reach anatomical posture during the extension as well as during flexion. Before the experiment, the participants conducted practice for five times to adapt to the Isokinetic device, and the experiment was conducted until the number of times the subjects are no longer able to exert his or her power.

The Isokinetic shortening contraction was performed three rounds at 60°/sec with 50 times each round and took a 10-second break after each 50 times.

2.2.3. Blood collection

Blood collection of subjects who performed shortening muscle contraction at 60°/sec using Isokinetic device was 20 ㎖ collection from arterial blood in the forearm and separated into plasma and serum. Blood collection was conducted for analysis of ammonia, lactic acid, and LDH in the blood during stabilization and immediately after the exercise, 24 hours after the recovery period, and 72 hours after the end of the exercise.

The plasma from the blood collected was immediately separated and commissioned to the N Clinical Examination Center in Gyeonggi-do to analyze, as the measurement of collected blood degrades at a fast pace if left at room temperature. The blood collected at room temperature because it degrades the measurement at a fast pace.

2.2.4. How to apply kinesio taping

With the position of muscle extended as much as possible, tape was applied without stretching, and I-shaped and Y-shaped tape was applied to the muscle's origin and insertion.

(1) Quadriceps taping

The subjects lie down and make the knee bend, fix the tape in Anterior Inferior Iliac Spine (AIIS), apply the tape on the front of the Rectus Femoris, and wrap the kneecap in a Y-shaped form.

(2) Hamstring taping

The subject attaches the tape to the 1/3 of the lower thigh starts from the upper part of the ischial tuberosity in a prone position, then breaks it in half in the longitudinal direction, one to the outside by the head of fibula and another to the lower part of the inner tibia.

(3) Vastus Medialis

The subject attaches the tape to the origin of the adductor while lying on the bed with the tip of the foot out, bring the tape over the insertion of vastus medialis with the legs open out, flexes the knee, and attaches it under the kneecap.

(4) Vastus Lateralis

The subject attaches the tape to the origin of the vastus lateralis while lying on the bed, bring it to the insertion of vastus lateralis, flexes the knee, and attaches it under the kneecap.

2.3. Data processing

In this study, data processing was conducted utilizing the SPSS 12.0 version program for Windows and calculated the average value (M) and standard deviation (SD) of each variable.

In order to verify differences in fatigue recovery blood variables resulted from application of Kinesio taping and timing (before exercise, immediately after exercise, 24 hours of recovery, 72 hours of recovery), two-way ANOVA with repeated measures were conducted. The significance level of all validation is set to $P<.05$.

3. Results

The results of blood variables associated with fatigue recovery after inducing muscle fatigue depending on the application of Kinesio taping are as follows.

3.1. Changes in ammonia in the blood

Changes in ammonia in the blood with/without application of taping during fatigue recovery process after performing artificial muscle fatigue exercise are shown in Table 2. In Table 2, changes in ammonia in the blood of applied group and non-applied group showed no statistically significant difference in the interaction between timing and group ($P>.05$).

Examining by main effect, in the taping applied group, it is shown 162.62±65.64(£g/dL) before exercise, 292.37±104.36(£g/dL) immediately after exercise, 208.37.50±57.83 (£g/dL) 24 hours of recovery, 205.87±51.66(£g/d12) 72 hours of recovery.

In the non-applied group, it is appeared 166.12±94.96(μg/dL) before exercise, 263.37±97.81(μg/dL) immediately after exercise, 201.25±58.47(μg/dL) 24 hours of recovery, 206.87±73.68(μg/dL) 72 hours of recovery.

Although there was a meaningful difference in timing, there were no statistically significant differences between the two groups ($P>.05$).

3.2. Changes in lactate concentration

In Table 2, the changes in lactic acid concentration of the applied group and non-applied group showed no statistically significant difference in interaction between the timing and the group.

Examining by main effect, in the taping applied group, it is shown 1.23±.28(mmol/L) before exercise, 9.07±2.25(mmol/L) immediately after exercise, .44±.37(mmol/L) 24 hours of recovery, and 1.08±.27(mmol/L) 72 hours of recovery.

In the non-applied group, it is appeared 1.27±.40(mmol/L) before exercise, 9.05±2.27(mmol/L) immediately after exercise, 1.56±.59(mmol/L) 24 hours of recovery, 1.50±.53(mmol/L) 72 hours of recovery, showing a statistically meaningful difference.

There were no statistically significant differences between the two groups (P>.05).

Table 1: Changes in blood variables related to fatigue recovery

	group	Before exercise	Exercise Immediately after	recovery 24 hours	recovery 72 hours	Source	F	p
ammonia µg/dL	apply	162.6 ±65.6	292.3 ±104.3	208.3 ±57.8	205.8 ±51.6	Time	33.88	.000***
						group	.048	.830
	Not applicable	166.1 ±94.9	263.3 ±97.8	201.2 ±58.4	206.8 ±73.6	When X group	.434	.733
Lactic acid mmol/L	apply	1.23 ±.28	9.07 ±2.25	1.44 ±.37	1.08 ±.27	Time	83.32	.000***
						group	.163	.693
	Not applicable	1.27 ±.40	9.05 ±2.27	1.56 ±.59	1.50 ±.53	When X group	1.006	.424
LDH (U/L)	apply	290.37 ±58.14	287.12 ±59.81	287.50 ±46.77	291.50 ±62.52	Time	.454	.719
						group	.124	.730
	Not applicable	330.12 ±163.23	301.12 ±60.34	293.00 ±37.06	272.62 ±42.16	When X group	.801	.517
CK (U/L)	apply	124.12 ±65.94	139.37 ±73.41	231.87 ±98.64	146.50 ±80.80	Time	12.278	.001**
						group	.570	.463
	Not applicable	180.75 ±141.74	192.62 ±161.20	257.75 ±117.75	144.75 ±86.56			

	When X group	.406	.752

M±SD***p<.000

3.3. LDH change

In Table 2, the changes in LDH of the applied group and non-applied group showed no statistically significant difference in interaction between the timing and the group.

Examining by main effect, in the taping applied group, it is shown 290.37±58.14(U/L) before exercise, 287.12±59.81(U/L) immediately after exercise, 287.50±46.77(U/L) 24 hours of recovery, and 91.50±62.52(U/L) 72 hours of recovery. In the non-applied group, it is appeared 0.12±163.23(U/L) before exercise, 301.12±60.34(U/L) immediately after exercise, 293.00±37.06(U/L) 24 hours of recovery, and 72.62±42.16(U/L) 72 hours of recovery, showing no significant difference.

There were no statistically significant differences between the two groups (P>.05).

3.4. CK change

In Table 2, the changes in CK of the applied group and non-applied group showed no statistically significant difference in interaction between the timing and the group. Observing by the main effect, in the taping applied group, it is shown 124.12±65.94(U/L) before exercise, 139.37±73.41(U/L) immediately after exercise, 281.87±98.64(U/L) 24 hours of recovery, and 146.50±80.80(U/L) 72 hours of recovery. In the non-applied group, it is appeared 180.75±141.74(U/L) before exercise, 192.62±161.20(U/L) immediately after exercise, 257.75±117.75(U/L) 24 hours of recovery, and 104.75±86.56(U/L) 72 hours of recovery, showing a statistically major difference. There were no statistically significant differences between the two groups (P>.05).

4. Discussion

After conducting three rounds of shortening muscle contraction with constant motion (50 times on each round) at 60°/sec with/without Kinesio taping, the results of changes in ammonia, lactic acid, lactate dehydrogenase (LDH), and CK related to fatigue are to be discussed through comparison with previous studies. In general, the reduction of muscle fatigue caused by taping can be considered because the blood vessels under the skin to which the taping is applied expands and blood flow is smoothed through the expanded blood vessels, thereby rapidly removing the muscle fatigue material (Hinman et al., 2003).

In a prior study which measured blood muscle damage indicators from taping, Liu et al. (2019) reported that changes in the concentration of blood ammonia with the effects of Kinesio taping on muscle strength improvement and indicating substances of blood fatigue and muscle damage had a tendency to increase as exercise progressed and decrease in the process of recovery, proving that Kinesio taping doesn't necessarily reduces the concentration of blood ammonia. With the effects of Kinesio taping on muscle strength improvement and indicating substances of blood fatigue and muscle damage. In this study, blood ammonia concentration increased immediately after exercise with Kinesio taping applied group but decreased over time, showing similar results to the prior study, suggesting that Kinesio taping does not help the recovery of the blood ammonia which is an indicator of muscle fatigue. Zanca, Mattiello, and Karduna (2015) reported as a result of changes in lactate concentration with/without taping of the lower extremities in the effects of Kinesio taping on the proprioception, lactic acid, and muscle pain after causing muscle fatigue. There was no substantial difference in changes of lactate concentration between groups (during stabilization, 5 minutes of recovery and 15 minutes of recovery), but there was a significant difference in non-applied and applied groups immediately after exercise, and there was no significant difference in lactate concentration due to the application of taping. Although this means taping helps to recover from short-term exercise fatigue due to temporary activation of the blood flow, unlike previous study, this research set the recovery time long as 24 hours for recovery and 72 hours. It means Kinesio taping did not significantly affect the change in lactic acid concentration after a long recovery time, which is believed to support the findings of Park, Lee and Han (2009).

In this study, both applied and non-applied group showed a tendency to present the highest level of LDH before exercise, then gradually recover immediately after exercise, to 24 hours of recovery, and 72 hours of recovery, showing different results from previous studies. The conflicting results in this study are shown to be due to different experimental conditions, such as the form, intensity, and time of exercise. Nevertheless, similar results have been presented with Liu et al. (2019) study that reported Kinesio taping does not reduce the concentration of LDH, and it is considered the application of Kinesio-taping used in this study does not help the recovery rate of LDH, a fatigue indicator. CK concentrations in biological tissue are highest in skeletal muscle (Ebbeling & Clarkson, 1989), and when stabilized in healthy muscles, CK is present in the protoplasm, resulting in lower blood concentrations (Cleak, & Eston, 1992). However, if muscle tissue is damaged through exercise, it increases epicyteperme ability, which increases blood concentration as CK moves to interstitial fluid. Therefore, blood CK concentrations can be used as an indicator of muscle disease or muscle damage. Although prior studies measuring blood muscle damage indicators with taping are extremely limited, this study showed no statistically significant difference in the growth and recovery of CK enzymes. A study by Evans et al. (1986) reported that CK recovered 72 hours after exercise, arguing that more research should be continued to clarify the differences in changes in CK. He argued that more research should be continued to clarify the differences in changes in CK. In this study, both applied and non-applied group recorded the highest level of CK from immediately after exercise to 24 hours of recovery and gradually decreased after 72 hours, showing a similar result to the prior study, but there was no change in CK concentration due to the presence of taping. This proves that Kinesio taping does not to help with the recovery speed of CK, an indicator of muscle fatigue.

5. Conclusion

The purpose of this study is in verifying the effect of Kinesio taping, by conducting three rounds of shortening muscle contraction with constant motion (50 times on each round) at 60°/sec with/without Kinesio taping, and examining the results of changes in ammonia, lactic acid, lactate dehydrogenase (LDH), and CK related to fatigue. The analysis of the data derived from this study resulted in the following conclusions: First, changes in blood ammonia after causing muscle fatigue with/without taping showed no statistically significant difference in the interaction of timing and group ($P>.05$).
There was a significant difference among the timings in the group ($P<.05$), and there was no significant difference in the concentration of blood ammonia between groups ($P>.05$). Second, the change in lactic acid concentration after inducing muscle fatigue with/without taping showed no statistically significant difference in the interaction between the timing and group($P>.05$). There was a significant difference among the timings in the group ($P<.05$), and there was no significant difference in the concentration of Lactic Acid between groups ($P>.05$). Third, changes in Concentration of LDH after causing muscle fatigue with/without taping presented no statistically significant difference in the interaction of timing and group ($P>.05$). There was no significant difference among the timings in the group ($P>.05$), and also no significant difference in the concentration of LDH between groups ($P>.05$). Fourth, changes in CK after causing muscle fatigue with/without taping presented no statistically significant difference in the interaction of timing and group ($P>.05$). There was a significant difference among the timings in the group ($P<.05$), and there was no significant difference in the concentration of CK between groups ($P>.05$). The above results show that Kinesio taping does not have a positive effect on the rapid recovery of blood ammonia, lactic acid concentration, LDH, and CK, which are fatigue substances. There are many ways presented for fatigue recovery, and the Kinesio taping treatment method is not believed to help reduce fatigue substances.

References

Abián-Vicén, J., Alegre, L. M., Fernández-Rodríguez, J. M., & Aguado, X. (2009). Prophylactic ankle taping: elastic versus inelastic taping. *Foot & ankle international, 30*(3), 218-225.

Armstrong, R. B. (1990). Initial events in exercise-induced muscular injury. *Medicine and science in sports and exercise, 22*(4), 429-435.

Asmussen, E., Hansen, O., & Lammert, O. (1965). The relation between isometric and dynamic muscle strength in man. *Testing and Observation of the Danish National Association for Infantile Paralysis: Communication, 20.*

Clark, M., & Lucett, S. (Eds.). (2010). *NASM essentials of corrective exercise training.* Lippincott Williams & Wilkins.

Cleak, M. J., & Eston, R. G. (1992). Muscle soreness, swelling, stiffness and strength loss after intense eccentric exercise. *British journal of sports medicine, 26*(4), 267-272.

Costill, D. L., Barnett, A., Sharp, R., Fink, W. J., & Katz, A. (1983). Leg muscle pH following sprint running. *Medicine and science in sports and exercise, 15*(4), 325-329.

Csapo, R., & Alegre, L. M. (2015). Effects of Kinesio® taping on skeletal muscle strength—A meta-analysis of current evidence. *Journal of Science and Medicine in Sport, 18*(4), 450-456.

Doss, W. S., & Karpovich, P. V. (1965). A comparison of concentric, eccentric, and isometric strength of elbow flexors. *Journal of Applied Physiology, 20*(2), 351-353.

Ebbeling, C. B., & Clarkson, P. M. (1989). Exercise-induced muscle damage and adaptation. *Sports medicine, 7*(4), 207-234.

Edwards, R. H. (1981, January). Human muscle function and fatigue. In *Ciba Found Symp, 82*, 1-18.

Enoka, R. M. (1996). Eccentric contractions require unique activation strategies by the nervous system. *Journal of applied physiology, 81*(6), 2339-2346.

Evans, W. J., Meredith, C. N., Cannon, J. G., Dinarello, C. A., Frontera, W. R., Hughes, V. A., ... & Knuttgen, H. G. (1986). Metabolic changes following eccentric exercise in trained and untrained men. *Journal of Applied Physiology, 61*(5), 1864-1868.

Fridén, J., Seger, J., & Ekblom, B. (1988). Sublethal muscle fibre injuries after high-tension anaerobic exercise. *European Journal of Applied Physiology and occupational physiology, 57*(3), 360-368.

Garcıa-Muro, F., Rodrıguez-Fernandez, A. L., & Herrero-de-Lucas, A. (2010). Treatment of myofascial pain in the shoulder with Kinesio taping. A case report. *Manual therapy, 15*(3), 292-295.

Gladden, L. B. (2010). Lactate transport and exchange during exercise. *Comprehensive Physiology*, 614-648.

Hinman, R. S., Crossley, K. M., McConnell, J., & Bennell, K. L. (2003). Efficacy of knee tape in the management of osteoarthritis of the knee: blinded randomised controlled trial. *Bmj, 327*(7407), 135.

Jeong, K. Y., & Kim, S. Y. (2010). Effect of lumbar stabilizing taping on the electromyographic activation of trunk and gluteal muscles during one-leg standing. *Journal of Korean Physical Therapy Science, 17*(12), 23-32.

Kaya, E., Zinnuroglu, M., & Tugcu, I. (2011). Kinesio taping compared to physical therapy modalities for the treatment of shoulder impingement syndrome. *Clinical rheumatology, 30*(2), 201-207.

Kim, G. S., Weon, J. H., Kim, M. H., Koh, E. K., & Jung, D. Y. (2020). Effect of weight-bearing wrist movement with carpal-stabilizing taping on pain and range of motion in subjects with dorsal wrist pain: a randomized controlled trial. *Journal of Hand Therapy, 33*(1), 25-33.

Liu, K., Qian, J., Gao, Q., & Ruan, B. (2019). Effects of Kinesio taping of the knee on proprioception, balance, and functional performance in patients with anterior cruciate ligament rupture: A retrospective case series. *Medicine, 98*(48).

Miles, M. P., & Clarkson, P. M. (1994). Exercise-induced muscle pain, soreness, and cramps. *The Journal of sports medicine and physical fitness, 34*(3), 203-216.

Park, G. B., Lee, W. J., & Han, S. W. (2009). The effects of kinesio taping therapy on exercise capacity and muscle fatigue. *The Korean Journal of Sports Science, 18*(2), 1101-1115.

Shulman, R. G., & Rothman, D. L. (2001). The "glycogen shunt" in exercising muscle: a role for glycogen in muscle energetics and fatigue. *Proceedings of the National Academy of Sciences, 98*(2), 457-461.

Viitasalo, J. H., & Komi, P. V. (1977). Signal characteristics of EMG during fatigue. *European Journal of Applied Physiology and Occupational Physiology, 37*(2), 111-121.

Zanca, G. G., Mattiello, S. M., & Karduna, A. R. (2015). Kinesio taping of the deltoid does not reduce fatigue induced deficits in shoulder joint position sense. *Clinical Biomechanics, 30*(9), 903-907.