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Effects of Various Deadlifts on the Muscle Activity of the Trunk and Lower Extremity

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Abstract

Background/Objectives: The purpose of this study is to identify changes in the muscle activity of the trunk and lower extremity during deadlift with various equipments (Kettlebell, Barbell, and Trap bar).

Method/Statistical Analysis: 29 people were selected to measure the muscle activity of the elector spinae, gluteus maximus, rectus femoris and rectus abdominis. One-way ANOVA with repeated measurements was conducted to determine the difference in muscle activity in various deadlift. The Bonferroni correction was used as a post-test to check the difference in muscle activity between the variousinterventions, and the significance level was set to 0.05. Statistical programs used SPSS Version 22.0 (Statistics Package for the Social Science).

Findings: There were significant differences in elector spinae, gluteus maximus,and rectus during the various deadlift.The rectus femoris showed higher muscle activity in trapbar deadlift than barbell deadlift and kettlebell deadlift. The elector spinae showed higher muscle activity barbell deadlift than kettlebell deadlift. The gluteus maximus showed higher muscle activity in barbell deadlift and kettlebell deadlift than deadlift.

Improvements/Applications: This study suggests thatmuscle activity vary depending on the barbell during deadlift.

Keywords: *Barbell deadlift, Elector spinae, Gluteus maximus, Kettlebell deadlift, Trapbar deadlift.*

Introduction

In modern society, due to the development of scientific civilization, many people use computer for a long time [1], and according to the National Health and Nutrition Survey, there are fewer people practicing moderate or higher physical activity [2]. Decreased physical activity may be a factor that causes musculoskeletal disorders such as back pain, osteoporosis, and osteoarthritis [3]. Therefore, it is necessary to exercise for the purpose of preventing muscle degradation and preventing musculoskeletal disorders, and a lot of weight training is selected as such means [4].

Weight training is a resistance exercise that uses barbells and dumbbells in general, and is an effective and stable exercise that can improve muscle strength and endurance by properly activating the body muscles [5]. In addition, it is effective in reducing body fat, which helps prevent disease and improve obesity, and improves motor control by improving muscle coordination and balance [4,6].

The most popular sports among weight training are squat, lunge and deadlift [7].Deadlift is an exercise that lifts weights on the floor, It is a good resistance exercise that strengthening the erector spine (ES), gluteus

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maximus (GM), Rectus femoris (RF), Hamstring, Lattismusdolsi, etc. [8,9].Deadlift, in particular, is frequently referred to for the improvement of gluteal amnesia caused by increased sedentary lifestyles, Gluteal amnesia causes problems with hip joint lose of function, pain, and problem on hip extension movement [10].In general, ES and GM are used as the main muscles at the hip joint extention, GM lose of function causes dysfunction in the back and knee joints[11].Therefore, the deadlift exercise is essential for modern people who have a lot of sedentary lifestyles to prevent dysfunction of back and lower extremity[8].

Deadlifts is use in a variety of method at sports and clinical rehabilitation field. The deadlift types include romanian deadlift, sumo deadlift, conventional deadlift, kettlebell deadlift, trapbar deadlift etc.Conventional deadlift is the most representative deadlift, a hip hinge movement with the foot at shoulder width, holding the barbell, keeping the back unbending, and chest protraction while maintaining the neutral posture of the spine[12].The Romanian Deadlift is a 45 degrees bend angle of the knee joint, descending along the thigh while holding a barbell, and maintain the lumbar curve and returning in reverse order [13].In Sumo Deadlift, the upper extremity in the starting position is the same as the Conventional Deadlift movement, but the lower extremity is extended to about twice the width of the shoulders, descending along the thigh and the hip joint angle is bent at about 90degrees and returned.[13].Weight training has been reported to differ in muscle activity according to posture even in the same exercise. Kwon and Kim (2018) compared GM muscle activations at 60% intensity when their respective exercises of the conventional deadlift, the romanian deadlift and the bent over row, which reported that GM muscular activity was high in the conventional deadlift compared to the romanian deadlift and the bent over row[12].This is due to the difference in the joint angle between conventional deadlift and romanian deadlift, conventional deadlift knee joint 90 degrees flextion and romanian deadlift knee joint 45 degrees flextion, the conventional deadlift's GM seems to have high muscle activity.In the study of Yu (2004), a comparison of the muscle activity ratios of the vastus medialisand vastus lateralismuscles during squats (general squat, hip joint adduction 20 degrees + toe out 20 degrees) according to the subject's posture[14]. It was reported that the muscle activity ratio of vastus medialis and vastus lateralis was increased in the squats hip joint adduction 20 degrees + toe out 20 degrees.This suggests that hip joint adduction is important for effective vastus medialis training and that selective muscle activity is possible on the exercise posture.

As can be seen in the preceding study, the study on comparison of muscle activity according to various deadlift method has been actively conducted.However, the study of apply various equipment to the deadlift is still insufficient.Therefore, this study is based on the kettlebell, barbell, and trap bar that are used mainly during deadlift; this is a comparative analysis of muscle activity of ES, GM, RF, RA. Therefore,the hypothesis of this study is that there would be a difference in muscle activity of both ES, both GM, both RF and both RA on the equipment used during deadlift.

Method

BTS Free EMG 1000 (BTS Bioengineering, Milano, Italy) was used to measure muscle activity of the trunk and lower extremity muscles during deadlift.

Barbell (BANSUK SPORT, KOREA) and plate (KU SPORTS, KOREA) were used to perform the barbell deadlift and to determine 50% of the initial 1RM. The length of the barbell is 1400mm long to match the length of the trap bar. The bar weighs 13 kg. The internal diameter was 50.4mm international standard size.The weight of the plate varied from 0.5kg to 15kg.

The trap bar (BADYSTREET, KOREA) was used to trap bar deadlift. The trap bar is 1400 mm long and weighs 14 kg. The trap bar, also called hexa bar, is a hexagon and must be used inside the bar. Thus, the trap bar is said to prevent the injury by matching the center of gravity and the center of mass. The kettlebell is mainly used for kettlebell swing, but also used to the kettlebell deadlift. The weight of the kettle bell was limited, but it was carried out with various weight kettlebells to meet 50% of 1RM.The 10RM load method of the 1RM test method, which is recommended by the National Strength and Conditioning Association (Anderson et al, 2018), was used.All deadlift were standardized on both feet by measuring the shoulder width before exercise and marking the shoulder width with tape on the floor. Each subject was asked to position their feet in shoulder width and then to get ready and the gaze to look straight ahead. Each deadlift was practiced several times before the measurement to familiarize the movement with three measurements.The ascending, descending and holding sections were kept for 5 seconds, and the data from 2 to 4 seconds, 6 to 9 seconds, and 11 to 14 seconds were analyzed except for the data of 1 and 5 seconds for each of the 15 seconds measured.Enough rest time was provided to prevent fatigue between measurements, and the experimenter performed the movement after the sign of start [19].

Statistical program used SPSS Version 22.0 (Statistical Package for the Social Science).To compare differences in muscle activity (RA, RF, ES, GM) between various deadlift (Barbell deadlift, Kettlebell deadlift, Trapbar deadlift), Statistical method used one-way ANOVA with repeated measure, the post-test performed the Bonferroni test.

Results and Discussion

The results are shown in table 1-3

Table 1. Ascending

Amount of activation	Barbell deadlift	Kettlebell deadlift	Trap bar deadlift	F	P
LRA	9.88±12.07	5.27±2.54	7.316±4.58	2.981	.076
RRA	17.12±22.01	7.15±4.96	10.08±6.18	6.176	.009
LRF	45.75±19.61	41.80±21.32	52.21±22.69	3.144	.059
RRF	37.06±17.01	34.71±19.49	41.89±19.49	3.217	.055
LES	51.05±18.56	42.53±12.86	53.91±37.88	4.807	.021a
RES	52.46±16.86	44.42±12.66	44.97±16.02	5.895	.006 a,b
LGM	29.63±12.12	27.06±16.60	26.80±11.38	2.471	.113
RGM	26.33±10.31	22.98±7.71	28.21±16.45	3.039	.073

*p<.05, a: There is a significant difference between Barbell deadlift and Kettlebell deadlift., b: There is a significant difference between Barbell deadlift and Trap bar deadlift., c: There is a significant difference between Kettlebell deadlift and Trap bar deadlift.

Table 2. Holding

Amount of activation	Barbell deadlift	Kettlebell deadlift	Trap bar deadlift	F	P
LRA	3.97±1.85	5.08±4.04	3.86±1.90	1.706	.210
RRA	6.28±5.50	5.46±4.69	5.11±4.39	1.827	.189
LRF	5.22±5.04	6.22±6.77	4.31±4.33	1.473	.244
RRF	5.22±5.04	6.22±6.77	4.31±4.33	1.473	.244
LES	20.79±9.79	22.44±10.83	13.63±7.74	7.783	.003 [b,c]
RES	22.27±9.01	24.58±8.46	14.26±6.10	19.375	.000 [b,c]
LGM	10.97±8.14	13.20±9.79	7.28±7.27	11.757	.001 [b,c]
RGM	9.96±5.33	13.02±7.34	7.44±5.08	16.173	.000 [a,b,c]

*p<.05

Table 3. Descending

Amount of activation	Barbell deadlift	Kettlebell deadlift	Trap bar deadlift	F	P
LRA	7.89±13.50	4.83±2.48	7.085±9.63	.943	.408
RRA	11.29±13.52	5.32±2.30	5.65±2.78	2.075	.155
LRF	35.96±20.69	39.83±22.68	46.85±21.71	3.748	.044[b]
RRF	28.62±15.40	31.81±17.67	42.12±22.52	8.463	.001 [b,c]
LES	48.29±17.46	37.31±13.94	47.81±26.61	10.385	.001[a]
RES	46.36±13.96	37.17±14.56	39.23±13.28	13.472	.000 [a,b]
LGM	13.27±4.59	17.84±19.87	14.63±7.10	1.199	.325
RGM	14.00±8.10	13.00±6.06	22.56±23.71	2.203	.139

*p<.05

Discussion

The purpose of this study was to compare muscle activity of RA, RF, ES, and GM on both sides of barbell deadlift, kettlebell deadlift, and trap bar deadlift. Existing exercises were mainly trained in the abdominal and trunk deep muscles, but recently, the studies emphasizes the importance of the lower extremity muscles and hip muscles for trunk stability and injury prevention[15]. Fredericson and Moore (2005) reported that weak hip muscles increase anterior shearing forces in the lumbar spine to instability in the trunk, in order to strengthen hip muscles, deadlift exercise is effective for strengthening trunk and hip muscles.Because deadlift uses local muscle for trunk stability, among which activates gluteus medius[16]. Therefore, this study aimed to suggest effective exercise method by comparing muscle activity of trunk and lower extremity muscle during barbell deadlift, kettlebel deadlift, and trapbar deadlift.

In this study, there was a significant difference between LRF and RRF in comparison with barbell deadlift, kettlebell deadlift and trapbar deadlift (P <0.05).In the descending section, LRF increased muscle activity at trapbar deadlift compared to barbell deadlift (P <0.05).In the descending section, RRF increased muscle activity in trapbar deadlift compared to barbell deadlift and muscle activity in trapbar deadlift compared to kettlebell deadlift (P <0.05).This result is thought to be due to increased angle of hip and knee joint during trap bar deadlift compared to barbell deadlift. According to Jang(2015), RF muscle activity increased due to the increase of the external moment arm as the knee joint angle increased during the squat[17].In addition, other studies reported that the muscle activity of the muscles around the knee increases because the external moment arm increases as the knee bending angle increases during the closed chain exercise[18].In this study, we also believe that RF muscle activity was high due to increased knee angle during trapbar deadlift when compared to barbell deadlift and kettlebell deadlift.

In this study, the muscle activity of ES in both sides during the barbell deadlift, kettlebell deadlift, and trabbar deadlift was significantly increased muscle activity at barbell deadlift compared to that of kettlebel deadlift in the ascending section and the descending section (P<0.05).This may be because the center of gravity of the barbell deadlift exercise was relatively ahead of kettlebell deadlift.In previous studies, moving the center of mass forward increased the external moment arm, which increased the muscle activiy of the lowback[19,20] .In this study, trapbar deadlift muscle activity was significantly decreased in the holding section compared to kettlebell deadlift and barbell deadlift (P <0.05).In a study comparing barbell deadlift and trapped deadlift, babell deadlift increased lumbar moment due to its center of mass, which increased the muscle activity of ES [21].In addition, Camara's study more used hamstrings and lower backs in barbell deadlift. And trapbar deadlift shows higher peak force, peak velocity, and peak power for barbell deadlift.In our study, barbell deadlift muscle activity was high in ascending section and descending section. In the holding section, trapbar deadlift both ES had the lowest muscle activity, similar to the above study.This is thought to reduce the moment of lumbar by spreading the load evenly across all joints, allowing the center of mass to be closer to the center of gravity with the horizontal distance from the ankle as the measurement point. Therefore, in the case of injured or painful person in lumbar, it is considered safer to do trapbar deadlift when performing deadlift.

In this study, muscle activity of both GM was significantly higher in barbell deadlift and bettlebell deadlift than in trapped deadlift in holding section (p <0.05).This result may be because the length-tension relationship of GM muscle is higher in barbell deadlift and kettlebell deadlift than trapbar deadlift. Therefore, barbell deadlift and kettlebell deadlift training may be helpful to strengthen the hip muscles.

Conclusion

This study investigated the muscle activity of ES, GM, RF, RA during deadlift exercise under various deadlift(barbell deadlift, trapbar deadlift, kettlebell deadlift). This study suggests that muscle activity vary depending on the barbell during deadlift. Further research will be needed to study motion analysis by using various barbells during deadlift exercise.

Ethical Clearance: Not required

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Conflict of Interest: Nil

References

1. Kim Jong-woo. The effect of the lumbar reinforcement exercise type on the lumbar and upper lower lumbar functions. Journal of Uninterpreted Ph.D., Keimyung University Graduate School, 2009.
2. Health and Welfare (2011). 5th Year 2 (2011) National Health and Nutrition Survey. Cheongju: Ministry of Health and Welfare
3. Health and Safety Corporation (2010). Effects of musculoskeletal diseases are analyzed (1st). Ulsan: the Health and Safety public corporation.
4. Hwang Woo-won and Kim Ki-jin (2004). Variation in concentration and body composition of blood lipid changes according to the difference in rest time between sets during weight training of normal and obese people. Journal of Physiology of the Korean Movement, 13(1): 87-100.Peterson MD, Rhea MR, Sen A et al. Resistance exercise for muscular strength in older adults: a meta-analysis. Ageing Res Rev. 2010;9(3):226-37.
5. Jun Hee-jong (2006). Comparison analysis of myocardial field of the lower extremities during squats, leg press, and leg extension exercises. Kyungpook National University. Master's Degree
6. Rippetoe,M.(2011). Starting strength: basic barbell training. WichitaFalls, TX: The AasgaardCompan
7. Huh Jin-young (2016). Number of deadlift, squats, and ketle bell swing movements Comparison of hip myocardial activity with myocardial inflection time. a master's degree thesis; an academy of Hanyang University
8. Frederic, D. (2005). Guide des mouvementsdemusculation/Strength training anatomy , (2rd ed). St. Paris, Human Kinetics.
9. McGill, S. M.(2007). Low Back Disorders: Evidence-based Prevention and Rehabilitation (2nd Ed.). Champaign, IL : Human Kinetics, 110-111.
10. Page, P., Frank, C., & Lardner, R.(2010). Assessment and treatment of muscle imbalance: the Janda approach. Champaign, IL: Human kinetics.
11. Kwon Man-geun, Kim Young-joo (2018) The Effect of Deduct Type and Bent over row Strength Exercise on Muscular Activity of Back Muscle, Journal of the Korea Sports Association, 16:3, 345-354
12. Choi Sung-kyu (2018). A comparative analysis on the activity of the femoral and femoral parietal muscles during the deadlift-waste operation. Bugyeong University Graduate School a master's degree in physical education
13. Yoo Won-kyu (2004) Effects of composite lower extremity posture on muscular activity of the broad and inner spines during static squats exerciseJournal of the Korean Association of Professional Physiotherapy, 11 (3)
14. Criswell E. Cram's introduction to surface electromyography: Canada: Jones & Bartlett Publishers; 2010 p. 342-364.
15. Berglund, L., Aasa, B., Hellqvist, J., Michaelson, P., & Aasa, U. (2015). Which patients with low back pain benefit from deadlift training?. The Journal of Strength & Conditioning Research, 29(7), 1803-1811.
16. Fredericson, M., & Moore, T. (2005). Muscular balance, core stability, and injury prevention for middle-and long-distance runners. Physical Medicine and Rehabilitation Clinics, 16(3), 669-689.
17. Jang Hye-in, Kim Soo-hyun, Seo Jong-chan, Ahn Hee-jung, Choi Mi-jung, Lee Dae-hee, Ph.D., and PT (2015). The effect of squat motion and knee joint angle on the muscular activity of the lower extremities. Journal of the Korean Academy of Science and Technology, 667-669
18. D'Lima, D. D., Poole, C., Chadha, H., Hermida, J. C., Mahar, A., & Colwell Jr, C. W. (2001). Quadriceps moment arm and quadriceps forces after total knee arthroplasty. Clinical Orthopaedics and Related Research®, 392, 213-220.
19. Caron, R. R., Wagenaar, R. C., Lewis, C. L., Saltzman, E., & Holt, K. G. (2013). Center of mass trajectory and orientation to ankle and knee in sagittal plane is maintained with forward lean when backpack load changes during treadmill walking. Journal of biomechanics, 46(1), 70-76.
20. Gullett, J. C., Tillman, M. D., Gutierrez, G. M., & Chow, J. W. (2009). A biomechanical comparison of back and front squats in healthy trained individuals. The Journal of Strength & Conditioning Research, 23(1), 284-292.
21. Swinton, PA, Stewart, A, Agouris, I, Keogh, JW, and Lloyd, R. A biomechanical analysis of straight and hexagonal barbell deadlifts using submaximal loads. J Strength Cond Res 25: 2000– 2009, 2011.