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COMPARISON OF MUSCLE ACTIVITIES BETWEEN BARBELL DEADLIFT AND JEFFERSON DEADLIFT

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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 barbell deadlift and Jefferson deadlift.*

Methods/Statistical analysis*: 24 people (14 male and 10 female) were selected to measure the muscle activity of the erector spinae, gluteus maximus, rectus femoris and rectus abdominis. Paired t-test was conducted to determine the difference in muscle activity during barbell deadlift and jefferson deadlift. Statistical programs used SPSS Version 22.0 (Statistics Package for the Social Science).*

Findings*: There were significant differences in rectus femoris and elector spinae during barbell deadlift and jefferson deadlift. Rectus femoris showed higher muscle activity in jefferson deadlift than barbell deadlift in the ascending phase and deccending phase (P>.05). Erector spinae showed higher muscle activity barbell deadlift than jefferson deadlift in the all phase (P>.05).*

Improvements/Applications*: This study suggests that jefferson deadlift is effective to increase muscle activity of RF with decrease muscle activity of ES than barbell deadlift.*

Keywords: *barbell deadlift, erector spinae, Jefferson deadlift, muscle activity, rectus femoris.*

1. INTRODUCTION

Modern people are in a state of lack of exercise due to an increase in sedentary life, which has led to a sharp increase in people with musculoskeletal disorders[1]. To prevent this, a variety of muscle strengthening exercises are needed, and busy modern people need high-strength training considering their time efficiency[2]. During high strength training, there is free weight exercise, which is widely used by the public, and free weight exercise is a squirt deadlift and bench press[3] Among them, the method of strengthening the posterior chain, weakened by sedentary life, is a deadlift[4].

Deadlift is exercise of the whole body that lifts object on the floor that improves muscle strength, endurance, coordination, and balance[5]. It is also effective in preventing and treatment low back pain by strengthening the posterior chain[6]. Among posterior chain, hip extensor strengthening is essential for preventing sports injuries, and lowering the risk of injury to modern people who are sedentary[7].

It has been proven by many researchers that the deadlift exercise helps with the muscle activity of the muscles in the posterior chain[8,9]. In McAllister's study, muscle activity was higher in gluteus maximus and biceps femoris at deadlift than prone leg curl and glute-ham raise[10]. The Nuzo study also showed that the muscle activity of the posterior chain was higher in deadlift than in pelvic thrust and ball back extension[11]. In Holmberg's study, the deadlift could decreased pain and dysfunction in patients with an intervertebral back pain with dysfunction[12].

The type of deadlift is used by changing the posture in barbell deadlift, such as romanian deadlift, conventional deadlift, sumo deadlift, etc. Deadlift exercises can also vary in type depending on the posture of the barbell, typical of which is jefferson deadlift, which has been frequently used in recent sports sites. There is deadlift that exercise using various instruments, such as the kettlebell deadlift, the dumbbell deadlift, and the trap-bar deadlift, performed by changing the instrument.

The method of barbell deadlift is to place the barbell in the center of the foot and hold it in an overgrip position to the width of the shoulder and hold it in the lumbar neutral position while holding the barbell with the hip joint flexion and extension and then sitting down[13]. Jefferson deadlift is performed by placing a barbell between the feet, unlike a barbell deadlift. Jefferson deadlift stands in front of the barbell, with one foot in front of the barbell and the other 90° external rotation, and hand uses an alternate grip. Alternate grip is a method of holding one hand by pronation and the other by supination.

Deadlift is implemented in various ways in sports training and therapeutic exercises in clinical practice. However, there is no study comparing the position of the barbell with the jefferson deadlift. Therefore, in this study, the muscle activity of the barbell deadlift was compared with that of the jefferson deadlift, which was not studied among the deadlift method.

2. Materials And Methods

2.1. Subjects

Twenty-four(14 male and 10 female) subjects were recruited for this study. The subjects voluntarily participated in the study. Exclusion criteria is those who had an orthopedic and neurosurgical disease during the last 6 months, and those with musculoskeletal pain, and BMI index is greater than 30kg/m^2 were excluded because of problems with EMG values[14]. Also excepted those who fail to perform deadlift. All subjects singed a study participation agreement, and no subjects were excluded due to exercise intensity or muscle pain during the study period.

2.2. Experiment equipment and tool

2.2.1. Surface EMG signal collect and analysis system

BTS Free EMG 1000(BTS Bioengineering, Milano, Italy) was used to measure muscle activity of the trunk and lower extremity muscles during deadlift. The EMG signal sampling rate is 1024Hz and 20~500Hz band pass filter is used to remove noise. The EMG signals measured at the electrodes are amplified 10 times through amplification to prevent noise and interference, and then moved along the cables to the patient unit and converted to digital data using an A/D converter at 16 bits. As soon as the collection was completed, the data collected in the patient unit was received via the WIFI to the access pointer connected to the computer and LAN cable, and the row data was automatically displayed by the YORAB(software, BTS co, Italy) software used by the FREEEMG. The RMS(root-mean-square) values of the EMG signals of each muscle for each movement were rectified in row data, and the data were analyzed through RMS process after integration [Figure 1].

Figure 1: BTS FREEEMG 1000

2.2.2. Barbell and Plate

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. 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[Figure 2].

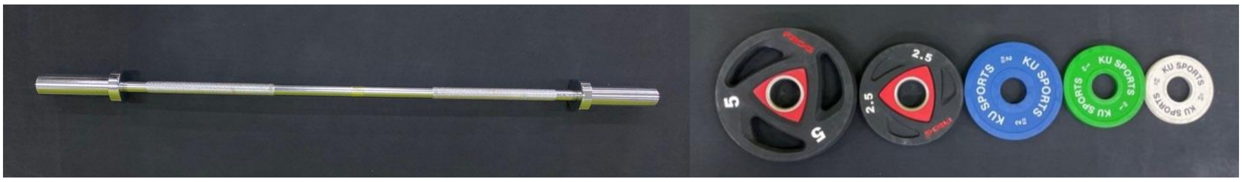

Figure 2 : Barbell and Plate

2.3. Experimental Method

2.3.1. EMG attachment

Before to the experiment, the subjects wore shorts and then wiped the skin to remove the dead cell from the skin with alcohol cotton before attaching the electrodes[15]. We mark the electrode attachment area of each muscle as small with oil pen to find out amount of the EMG signal of rectus abdominis(RA), rectus femoris(RF), erector spinae(ES), and gluteus maximus(GM). The electrode attaching method was attached with reference to the method of Cram (2010)[16]. Electrode attachment sites are shown in [Table 1].

Table 1 : EMG attachment placement

Muscle	Placement
Rectus abdominis	3 ㎝ apart and parallel to the muscle fibers of rectus so that they located approximately 2cm lateral and across form the umbilicus over the muscle belly.
Rectus femoris	approximately Distance between the knee and the iliac spine.
Gluteus maximus	Over the greatest muscle bulk proximal to a line between greater trochanter and the ischial tuberosity.
Erector spinae	3 ㎝ lateral to L4 spinous process

2.3.2. EMG Signal Normalization

We used the MVIC(maximal voluntary isometric contraction) collected for 5 seconds to normalization the EMG signal. For the measurement posture, refer to Daniels and Wanderingham's manual muscle test method [17]. The normalization process of each muscle is as follows.

$$\%\text{MVIC} = \text{RMS} \times \frac{1}{MVIC} \times 100$$

In the MVIC measuring method of RA, the leg was fixed in the supine position and the hands were clasped behind the neck and lifted up to the inferior angle of the scapula. In the MVIC measuring method of RF, subjects were measured with their waist straight on the therapeutic table, with their arms crossed in front of the chest, and with resistance in the direction of flexion the knee to the ankle when the knee was extension. In the MVIC measuring method of ES, the pelvis was fixed at the prone position so that both hands were clasped behind the head and lifted up to the navel. In the MVIC measuring method of GM, the knee joint did flexion, the pelvis was fixed at the prone position, and the maximum resistance of the distal femur was measured. During the measurement, the subject was orally notified for 5 second and encouraged through the words so that the subject could maintain maximum contraction. The average signal intensity that measures the maximum isometric muscle contraction for 5 seconds and treats the data value with RMS processing, except the 1 second in the beginning of 5 seconds and 1 second in the back of 5 seconds was used as 100% MVIC[18]. The average value of the three measurements was used. We gave a one-minute break between measurements.

2.3.3. 1RM measuring method

1RM measurement method was based on the protocol recommended by the National strength and conditioning association [19]. This method is divided into 10 steps and measures by estimating, increasing, or decreasing the weight until 1RM is measured. The intermeasurement resting time gives during 3min and it is ideal to complete the test within 3-5 repeat measurements.

2.3.4. Exercise method

In this study, the exercise was conducted after the subjects were given a sufficient explanation and demonstration of the exercise method before the exercise. 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. Enough rest time was provided to prevent fatigue between measurements, and the experimenter performed the movement after the sign of start. Rest time was about 2-3 minutes [20].

2.4. Data processing method

Differences in RA, RF, ES, GM muscle activity during barbell deadlift and jefferson deadlift were tested using pared t –test. Statistical program used SPSS(Statistical Package for the Social Science) Version 22.0 (IBM Corp, Armork, NY, USA), and p-value <.05 was deemed statically significant.

3. Results And Discussion

3.1. Result

During the ascending phase, there was a significant difference between the barbell deadlift and the jefferson deadlift in the left RF(p<0.05), and the jefferson deadlift (60.66±20.91) shown a muscle activity higher than the barbell deadlift (37.58±17.81). During descending phase, there was a significant difference between the barbell deadlift and the jefferson deadlift in the Left RF(p<0.05), and the jefferson deadlift (45.54±20.17) shown a muscle activity higher than the barbell deadlift (32.74±19.00)[Table 2].

During the ascending phase, there was a significant difference between the barbell deadlift and the jefferson deadlift in the right RF(p<0.05), and the jefferson deadlift (51.01±23.34), shown a muscle activity higher than the barbell deadlift (35.00±18.50). During descending phase, there was a significant difference between the barbell deadlift and the jefferson deadlift in the right RF(p<0.05), and the jefferson deadlift (43.17±18.93) shown a muscle activity higher than the barbell deadlift (26.85±15.14)[Table 2].

During the ascending phase, there was a significant difference between the barbell deadlift and the jefferson deadlift in the left ES(p<0.05), and the barbell deadlift (50.29±19.07) shown a muscle activity higher than the jefferson deadlift (32.86±17.52). During descending phase, there was a significant difference between the barbell deadlift and the jefferson deadlift in the Left ES(p<0.05), and the barbell deadlift (51.28±20.97) shown a muscle activity higher than the jefferson deadlift (25.39±16.33)[Table 2].

During the ascending phase, there was a significant difference between the barbell deadlift and the jefferson deadlift in the right ES(p<0.05), and the barbell deadlift (48.28±16.79) shown a muscle activity higher than the jefferson deadlift (28.83±11.17). During holding phase, there was a significant difference between the barbell deadlift and the jefferson deadlift in the right ES(p<0.05), and the barbell deadlift (20.95±8.78) shown a muscle activity higher than the jefferson deadlift (12.47±6.07). During descending phase, there was a significant difference between the barbell deadlift and the jefferson deadlift in the right ES(p<0.05), and the barbell deadlift (45.94±14.72) shown a muscle activity higher than the jefferson deadlift (19.59±8.02)[Table 2].

Table 2 : muscle activity comparison of Barbell deadlift and Jefferson deadlift

muscle	Phase	Barbell deadlift	Jefferson deadlift	T	*p*
Left RA	Ascending	9.81±9.71	8.38±6.21	.599	.555
	Holding	4.09±2.27	3.87±2.30	.433	.669
	Descending	5.61±3.04	5.00±2.55	.831	.414
Right RA	Ascending	12.45±11.63	11.55±8.55	.329	.745
	Holding	6.32±4.71	4.90±3.16	1.394	.177
	Descending	8.53±7.03	6.95±4.91	.900	.377
Left RF	Ascending	37.58±17.81	60.66±20.91	-4.934	.000*
	Holding	6.26±6.95	6.37±5.00	-.079	.938
	Descending	32.74±19.00	45.54±20.17	-2.318	.030*
Right RF	Ascending	35.00±18.50	51.01±23.34	-3.015	.006*
	Holding	5.72±7.07	8.08±7.18	-1.293	.209
	Descending	26.85±15.14	43.17±18.93	-3.908	.001*
Left ES	Ascending	50.29±19.07	32.86±17.52	3.830	.001*
	Holding	22.46±10.83	18.57±10.22	1.512	.144
	Descending	51.28±20.97	25.39±16.33	5.473	.000*
Right ES	Ascending	48.28±16.79	28.83±11.17	6.453	.000*
	Holding	20.95±8.78	12.47±6.07	3.765	.001*
	Descending	45.94±14.72	19.59±8.02	8.352	.000*
Left GM	Ascending	32.91±16.11	31.37±12.25	.470	.643
	Holding	12.93±9.83	10.58±11.03	1.253	.223
	Descending	16.77±12.07	18.67±11.94	-.981	.337
Right GM	Ascending	32.16±15.29	26.32±9.16	1.683	.106
	Holding	10.34±5.12	8.32±6.93	1.278	.214
	Descending	19.63±16.55	14.88±6.99	1.162	.257

*p<.05

Abbreviations: RA: Rectus Abdominis, RF: Rectus Femoris, ES: Erector Spinae, GM: Gluteus Maximus

3.2. Discussion

The purpose of this study was to compare muscle activity of RA, RF, ES, and GM on both sides of barbell deadlift and jefferson deadlift. As sedentary living increases, the lower extremity muscle decreases and causes gluteal amnesia. The gluteal amnesia causes problems with the movement of the hip joint, so gluteus maximus needs to be strength[21]. Deadlift is the main exercise that strengthens the gluteus maximus of the posterior chain while strengthening the lower extremity[22]. Therefore, this study sought to find out about jefferson deadlift, which was not studied in the deadlift method, and to suggest a more effective exercise method.

In this study, both RF showed significant differences in ascending phase and descending phase (P<0.05). Left RF showed higher muscle activity at jefferson deadlift (60.66±20.91) compared to barbell deadlift (37.58±17.81) in the ascending phase. In the descending phase, the muscle activity was also shown at jefferson deadlift (51.01±23.34) compared to barbell deadlift (32.74±19.00). Right RF showed higher muscle activity at jefferson deadlift (60.66±20.91) compared to barbell deadlift (35.00±18.50) in the ascending phase. In the descending phase, the muscle activity was also shown at jefferson deadlift (43.17 ± 18.93) compared to barbell deadlift (26.85 ± 15.14). The reason for jefferson deadlift showed higher muscle activity than barbell deadlift in the both RF is thought to be the difference between flexion angle of the knee and external moment arm.

In Fry`s study, when the knee torque was compared with the restricted knee joint squat group and the unrestricted knee joint squat group. It was reported that RF muscle activity increased as knee flexion angle increased in unrestricted knee joint squat(150.1 Nm) compared to restricted knee joint squat(117.1 Nm)[23]. In this study, the knee flexion angle was increased in the jefferson deadlift compared to the barbell deadlift. Therefore, the knee torque increases in the jefferson deadlift, resulting in higher RF muscle activity. In escimilla's study, the sumo deadlift and conventoinal deadlift were compared. They throught that the external moment arm of the knee extensor was larger in the three-dimensional(3-D) of the sagittal plane and the coronal plane at sumo deadlift compared to the conventoinal deadlift[24]. Similar to the preceding study, this study appears to have shown higher muscle activity because the knee extensor external moment arm in jefferson deadlift is larger in the three-dimensional(3-D) in the sagittal plane and coronal plane than the barbell deadlift.

In this study, left ES showed significant differences in ascending phase and descending phase (P<0.05). Left ES showed higher muscle activity at barbell deadlift (50.29±19.07) compared to jefferson deadlift (32.86±17.52) in the ascending phase. In the descending phase, the muscle activity was also shown at barbell deadlift (51.28±20.97) compared to jefferson deadlift (25.39±16.33). Right ES showed significant differences in all phases (P<0.05). Right ES showed higher muscle activity at barbell deadlift (48.28±16.79) compared to jefferson deadlift (28.83±11.17) in the ascending phase. In the holding phase, the muscle activity was also shown at barbell deadlift (20.95 ± 8.78) compared to jefferson deadlift (12.47 ± 6.07). In the descending phase, the muscle activity was also shown at barbell deadlift (45.94 ± 14.72) compared to jefferson deadlift (19.59 ± 8.02). The reason barbell deadlift showed higher muscle activity than jefferson deadlift in the both ES is thought to be the difference between the stance wide and the knee flexion angle and the external moment arm of ES. Another reason is that jefferson deadlift grip position limits the movement of the trunk.

In Yoon's study, the increased knee flexion angle and lager stance width, lead to lower muscle activity of ES during lifting task [25]. In this study, the muscle activity was lowered due to the large knee flexion angle in the jefferson deadlift. Also, we thought that ES muscle activity was lower than barbell deadlift because of its large stance width at jefferson deadlift. In Anderson's study, ES muscle activity was higher in barbell deadlift compared to trap-bar deadlift, and increased in barbell deadlift as ES external moment arm increased in barbell deadlift than trap-bar deadlift[26]. In this study, ES muscle activity in barbell deadlift compared to jefferson deadlift is thought to be due to the large external moment arm of ES in barbell deadlift compared to jefferson deadlift. In Kang's study, It has been confirmed that the muscle activity of ES is reduced as the lumbar bending angle is reduced when taping is applied during lifting[27]. In this study, jefferson deadlift grip position limits the movement of the trunk in the anterior and posterior in the sagittal plane, which appears to have reduced ES muscle activity.

ES over activation causes spasm, which leads to weakness and back pain, which is called pain-spasm-pain cycle[28]. Jefferson deadlift had lower muscle activity of ES than babel deadlift. Therefore jefferson deadlift is expected to reduce the external moment arm of the ES to prevent lower back pain and to help distribute the load evenly across all joints and prevent the pain-linking cycle.

4. Conclusion

This study compared and analyzed the muscle activity (ES, GM, RF, RA) of the barbell deadlift and jefferson deadlift. As a result, the muscle activity of RF was higher Jefferson deadlift than barbell deadlift, and ES muscle activity was higher barbell deadlift than Jefferson deadlift(p<05). For GM, there was no significant difference (p<.05). Therefore, for RF training, people with Jefferson deadlifts are more efficient and have lower back pain recommend Jefferson deadlift, which is less active of ES.

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