Bilateral Electromyographic Analysis of the Sumo and Conventional Deadlift

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1. Introduction

The conventional (Fig 1.) and sumo (Fig 2.) style deadlift are an integral component of strength training programmes in athletes and are primarily used to strengthen the back, legs and hips (1). The deadlift involves the lifter standing in a flexed position with two hands gripped on a weightlifting bar. The bar is lifted until they stand erect with the knees locked and the shoulders back. These deadlift variations differ by their beginning stance and hand placement (2, 3).

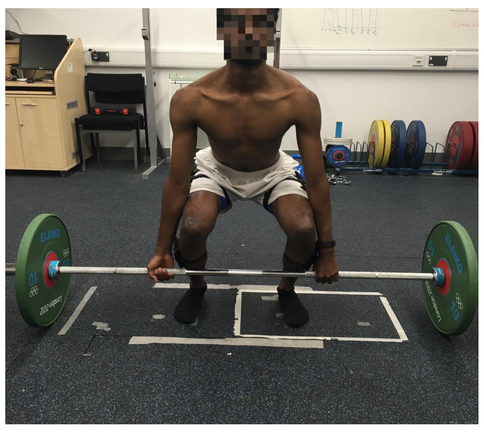

Figure 1. Conventional deadlift style (arms outside knees).

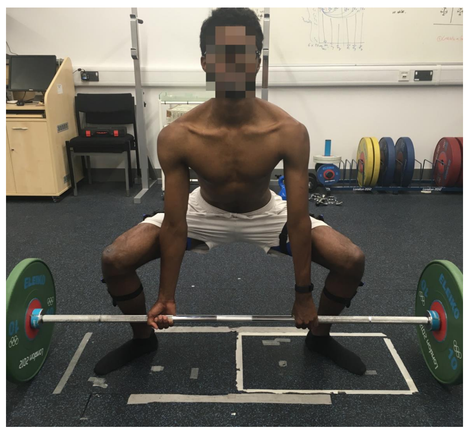

Figure 2. Sumo deadlift style (arms in-between knees)

Common lifting errors include a rounded lower back with kyphosis of the thoracic spine. The ability to maintain a neutral spine slowly diminishes under maximal loads due to greater forces of up to 8.5% (4) generated by the hip extensor muscles than that of the erector spinae muscles. This places high tensile stress on the posterior ligaments of the spine (5). Consequently, lifting with a flexed lumbar spine increases intervertebral shear and heightens risk of intervertebral disc injury.

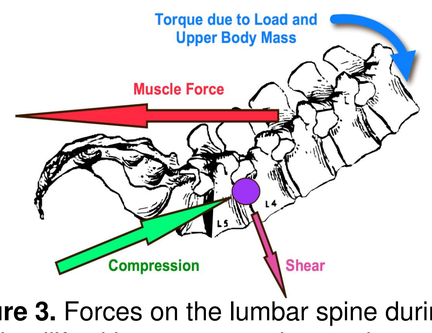

Figure 3. Forces on the lumbar spine during a deadlift with proper muscle recruitment

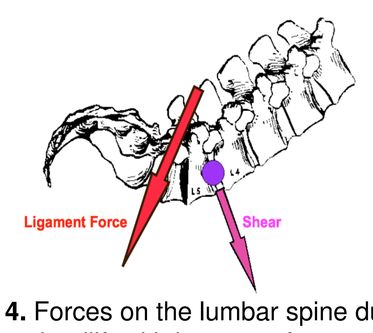

Figure 4. Forces on the lumbar spine during a deadlift with improper form

There is limited research investigating muscle activity between the sumo and conventional deadlift. Till now, only one study has employed electromyography (EMG) with unilateral electrode placement for the biomechanical analysis of the deadlift (6).

2. Aims

- To compare the differences in muscular EMG activity between the sumo and conventional deadlift using 60%, 70% and 80% of one-repetition maximum (1RM) weight
- To explore the symmetrical usage of muscles during the sumo and conventional deadlift
- To compare the muscular EMG activity between the pre-activation phases (PAP) and main-activation phases (MAP) of muscles during the sumo and conventional deadlift

3.1 Methods

Participants

•Ethical approval was obtained from QMUL Ethics Committee.
•Seven participants were recruited for this study from January 2016 till May 2016.
•Mean age, height, weight and BMI were 21.71 years (± 0.76 years), 1.74m (± 0.06m), weight 70.8kg (± 7.68kg) and 23.44 (± 2.38) respectively.
•Participants were included if they:

i. Had at least 18 months of deadlift experience
ii. Had experience performing the sumo & conventional deadlift
iii. Were currently healthy with no previous injury
iv. Had previous muscular/neuropathic lower back injury but asymptomatic for the past 6 months

Kinematic & Electromyographic measures

•CodaMotion™ active infrared motion analysis system was used to measure knee joint angles
•Participants were fitted with active infrared marker clusters attached to the legs in accordance to the Cleveland clinic protocol (7)
•14-channel Delsys™ wireless surface EMG system was used to quantify muscle activity
•Electrodes were placed on 7 muscles bilaterally according to SENIAM guidelines (Fig 5. & Fig. 6)

EMG Muscle placement
1. Rectus femoris
2. Biceps femoris
3. Adductor longus
4. Gluteus Medius
5. Gluteus Maximus
6. L3 paraspinals
7. Rhomboids

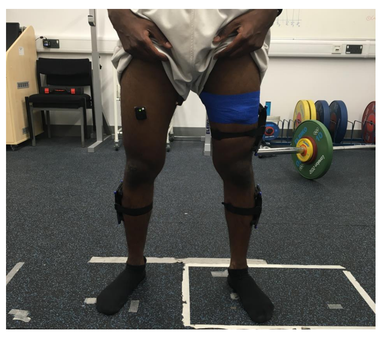

Figure 5. EMG and cluster placement (anterior)

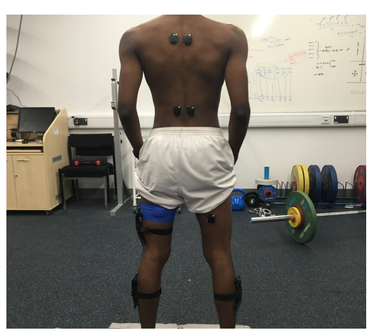

Figure 6. EMG and cluster placement (posterior)

3.2 Methods

Protocol

•Testing took place at the Human Performance Laboratory at Queen Mary University
•100% 1RM was calculated using the Brzycki and Landers 1RM formula (8,9) by asking the participant's normal repetition range and deadlift weight
•Each participant was asked to perform one repetition of the sumo and conventional deadlift until >70% marker visibility was achieved at 60%, 70% and 80% 1RM

Statistical analysis

•SPSS – Test-retest reliability using intra-class correlation coefficient
•MatLab – 4-way ANOVAN was used to test interaction and main effects with the factors: symmetry, deadlift style, %1RM and activation phases with significance set at $p<0.05$
•Post-hoc analysis using Bonferroni correction with significance set at 0.05 was completed for multiple comparison of means

1. Baseline Phase (0.2s window of static movement)
2. Pre-activation phase (0.5s window before start of knee extension)
3. Main-activation phase (start of knee extension > end of knee extension)

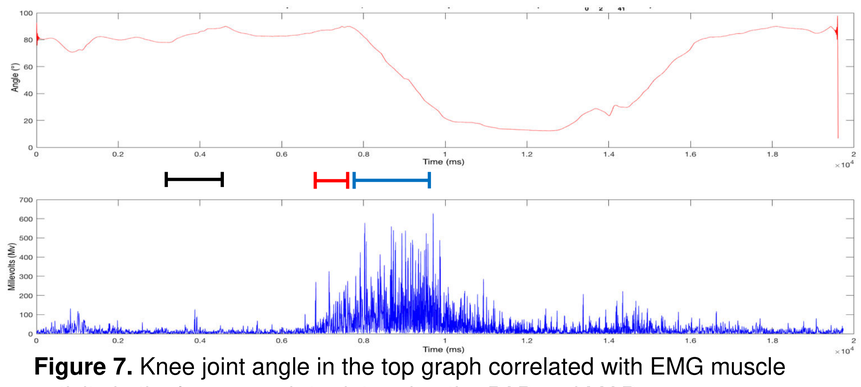

Figure 7. Knee joint angle in the top graph correlated with EMG muscle activity in the lower graph to determine the PAP and MAP

4. Results

- Significant differences in EMG activity were seen for the rhomboids between deadlift styles($p<0.05$)
- Significant differences for the EMG activity were seen between the left and right biceps femoris and rectus femoris ($p<0.05$)
- The main activation phase EMG activity was significantly greater than the pre-activation phase for the biceps femoris and gluteus medius ($p<0.0001$)
- %1RM had no main effect on EMG activity ($p>0.05$)

	Gluteus Medius	Gluteus Maximus	Biceps Femoris	Rectus Femoris	L3 Parapspinals	Adductor Longus	Rhomboids
Symmetry	✕ ✕	✕ ✕	✓ ✕	✓ ✕	✕ ✕	✕ ✕	✕ ✕
Deadlift style	✕ ✕	✕ ✕	✕ ✕	✕ ✕	✕ ✕	✕ ✕	✓ ✕
%1RM	✕ ✕	✕ ✕	✕ ✕	✕ ✕	✕ ✕	✕ ✕	✕ ✕
Activation phases	✓ ✓	✕ ✕	✓ ✓	✓ ✕	✕ ✕	✓ ✕	✓ ✕

LEGEND

✕– Non-significant ANOVA ($p>0.05$)

✓– Significant ANOVA ($p<0.05$)

✕ – Non-significant post-hoc analysis($p>0.05$)

✓ – Significant post-hoc analysis($p<0.05$)

Table 1. Table displaying the significant results that were found for 4-way ANOVA and post-hoc analysis

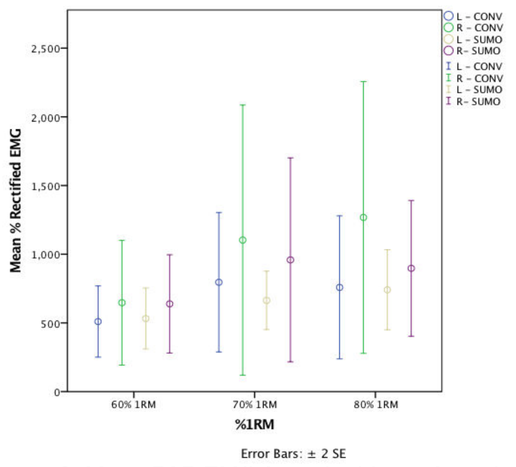

Figure 8. Mean PAP EMG from the biceps femoris.

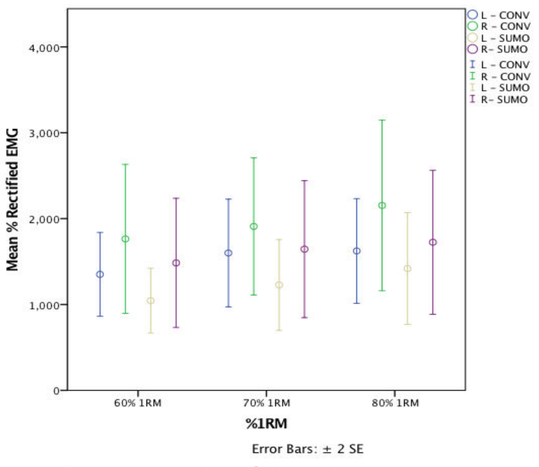

Figure 9. Mean MAP EMG from the biceps femoris.

5. Discussion

- Significant differences for the rhomboids only, suggest that there are minimal differences in muscular recruitment between the sumo and conventional deadlift
- Evidence has shown that muscle imbalances can cause injury (10). Significant differences were seen between the left and right rectus femoris and bicep femoris and this may suggest increased risk of injury due to asymmetrical forces applied to compensatory ligaments on the weaker side. Furthermore asymmetrical muscular hypertrophy could predispose to chronic injury
- Significantly greater MAP EMG activity for the biceps femoris and gluteus medius were seen and training these muscles may be beneficial for weightlifters who struggle post barbell lift-off
- No findings from our study to show that %1RM significantly changes muscle recruitment during deadlifts

6. Conclusion

- Recommendations from preliminary findings include screening for leg asymmetry using simple functional strength tests such as single leg jumps and 5-hop tests with consideration of unilateral strength exercises for the weaker leg. However caution should be taken to these recommendations due to the small sample size (11)
- Strengthening the biceps femoris and gluteus may aid post barbell lift-off
- Further research should employ multi-channel EMG to compare bilateral symmetry of other musculature and also explore how the different deadlift grips may affect EMG muscle activity in a larger sample size

References

1. Bird S, Barrington-Higgs B. Exploring the deadlift. Strength & Conditioning Journal. 2010 Apr 1;32(2):46-51.
2. Piper TJ, Waller MA. Variations of the Deadlift. Strength & Conditioning Journal. 2001 Jun 1;23(3):66.
3. International Powerlifting Federation (2015). Technical rules book.
4. Cholewicki J, McGill SM, Norman RW. Lumbar spine loads during the lifting of extremely heavy weights. Medicine and science in sports and exercise. 1991 Oct;23(10):1179-86.
5. Leyland T. Biomechanical Analysis of the Deadlift. PDF available from: <http://www.sfu.ca/~leyland/Kin201%20Files/Deadlift%20Mechanics.pdf> [Accessed 27th April 2016]
6. Escamilla RF, Francisco AC, Kayes AV, et al. An electromyographic analysis of sumo and conventional style deadlifts. Med Sci Sports Exerc 34: 682-688, 2002.
7. Zeller BL, McCrory JL, Kibler WB, et al. Differences in Kinematics and Electromyographic Activity Between Men and Women during the Single-Legged Squat*. The American journal of sports medicine. 2003 May 1;31(3):449-56
8. Brzycki M. Strength testing—predicting a one-rep max from reps-to-fatigue. Journal of Physical Education, Recreation & Dance. 1993 Jan 1;64(1):88-90.
9. Lander J. Maximum based on reps. NSCA journal. 1985;6:60-1.
10. Oddsson LI, De Luca CJ. Activation imbalances in lumbar spine muscles in the presence of chronic low back pain. Journal of applied physiology. 2003 Apr 1;94(4):1410-20..
11. Newton RU, Gerber A, Nimphius S, et al. Determination of functional strength imbalance of the lower extremities. The Journal of Strength & Conditioning Research. 2006 Nov 1;20(4):971-7.