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COMPARISON OF MUSCLE ACTIVATION AND PERFORMANCE DURING 6 RM, TWO- LEGGED FREE-WEIGHT SQUATS

PRIMERJAVA MIŠIČNE AKTIVACIJE IN USPEŠNOSTI PRI POČEPIH NA OBEH NOGAH PRI DVIGOVANJU UTEŽI 6-RM

ABSTRACT

The aim of this study was to compare 6-RM performance and muscle activation in two-legged, free-weight squats. Fifteen resistance-training males (age 24 ± 4 years, body mass 82 ± 11 kg, height 179 ± 6 cm) with 6 ± 3 years of resistance-training experience conducted one set of 6 RM. The barbell kinematics and EMG activity of *vastus lateralis, vastus medialis, rectus femoris, biceps femoris* and *erector spinae* were measured in the downward and upward part of each of the six repetitions. The total lifting time increased, but only from repetition 2 and 3 to 4 and later. Further, the peak and average velocity in the upward part decreased from repetition 4 and later. For the downward part, only repetition 1 showed significantly longer lifting times and lower peak velocity compared with the other five repetitions. The EMG activity of most muscles was significantly lower in the first two repetitions compared with the other repetitions. There was similar muscle activity in the final four repetitions. To avoid fatigue (decreased barbell velocity) while ensuring maximal EMG activation during training, we recommend only performing 3 to 4 of the six repetitions with the 6-RM load since similar muscle activity was observed after repetition 4. Therefore, to avoid fatigue in the final repetitions, the number of sets performed with a high level of quality in each session may be increased as well as the training frequency, which may help athletes gain muscle strength.

Key words: EMG, resistance exercise, kinematics

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IZVLEČEK

Namen raziskave je bil primerjati mišično aktivacijo in uspešnost pri počepih na obeh nogah pri dvigovanju uteži 6-RM. Petnajst moških, ki se ukvarjajo z vadbo z uporom (starost 24 ± 4 leta, telesna masa 82 ± 11 kg, telesna višina 179 ± 6 cm) in imajo 6 ± 3 leta izkušenj s tovrstno vadbo, je opravilo eno serijo 6-RM. Barbellova kinematika in EMG aktivnost mišic *vastus lateralis, vastus medialis, rectus femoris, biceps femoris* in *erector spinae* sta bili izmerjeni med dvigom in spustom pri vsaki od šestih ponovitev. Skupni čas dvigovanja se je povečal, vendar samo od 2. in 3. ponovitve na 4. in naslednje ponovitve. Poleg tega sta se največja in povprečna hitrost med dvigom in spustom zmanjšali od 4. ponovitve naprej. Pri spustu smo samo pri 1. ponovitvi zabeležili pomembno daljši čas dvigovanja in nižjo največjo hitrost v primerjavi z ostalimi petimi ponovitvami. EMG aktivnost je bila pri večini mišic pomembno nižja pri prvih dveh ponovitvah v primerjavi z ostalimi. V zadnjih štirih ponovitvah je bila mišična aktivnost podobna. Da bi se izognili utrujenosti (zmanjšana Barbellova hitrost) in ohranili maksimalno EMG aktivacijo med vadbo, priporočamo izvajanje samo 3–4 ponovitev od šestih (6-RM), saj smo od 4. ponovitve naprej opazili podobno mišično aktivnost. Da bi se izognili utrujenosti pri zadnjih ponovitvah, se lahko povečata število kakovostno izvedenih serij in pogostost vadbe, ki lahko športnikom pomaga pridobiti mišično moč.

Ključne besede: EMG, vadba z uporom, kinematika

INTRODUCTION

In weight lifting and the majority of sports including ball sports, the two-legged squat is one of the most popular exercises for the lower body. Athletes often carry out a number of sets at sub-maximal loads with several repetitions at a certain percentage of 1 RM until exhaustion. During these sets at sub-maximal loads, performance often decreases, i.e. lower barbell velocity, decreased power and force (van den Tillaar & Saeterbakken, 2014; Duffey & Challis, 2009; Sanchez-Medina & Gonzalez-Badillo, 2011). These decreased variables are seen as indicators of neuromuscular fatigue that is probably influenced by changes in muscle activation patterning (van den Tillaar & Saeterbakken, 2014). However, the evidenced-based literature examining electromyographic muscle activity (EMG) in sub-maximal loads (e.g. 6 RM) to exhaustion is limited. Therefore, little is known about muscle patterning during these repetitions.

Previous studies investigating neuromuscular fatigue and muscle patterning during strength training produced conflicting results. Gentil, Oliveira, Valdinar, Do Carmo, & Bottaro (2007) and Brennecke et al. (2009) showed increased muscle activation during sets of resistance exercises in experienced strength-trained subjects, in contrast to Häkkinen (1993) and Gerdle et al. (2000) who determined decreased EMG activity as measured by amplitude following sub-maximal strength loading or Lindström, Karlsson, & Lexell (2006) who reported no EMG amplitude changes. Some limitations of these studies are the number of repetitions conducted, which can be compared with strength endurance training (100 contractions) and not with regular maximal strength training. Further, isokinetic training was used (Lindström, Lexell, Gerdle, & Downham, 1997; Lindström, Karlsson, & Lexell, 2006) whose application to most athletic training appears questionable in terms of external validity (Abernethy, Wilson, & Logan, 1995).

In strength training with free weights, Walker, Davis, Avela, & Häkkinen (2012) showed that training 15 sets of 1 RM with 3 minutes of rest in between for subjects without resistance training experience decreased the EMG amplitude, while it increased in training with 5 sets of 10 RM with 2 minutes of rest in between. In addition, when examining bench press kinematics during 6 RM lifts van den Tillaar & Saeterbakken (2013) showed that the total lifting time increased and the velocity in the upward part decreased during the six repetitions. During the downward part, the opposite was found: the time decreased and velocity increased. Generally, EMG amplitude increased during the six repetitions in the upward part, while only three of the seven measured muscles showed an increase in the downward part in 6-RM bench pressing. Van den Tillaar & Saeterbakken (2013) concluded that, while the bench pressing performance decreased (lower barbell velocities and longer lifting times) during the repetitions in 6-RM execution, EMG increased in the prime movers and the trunk stabilisers (abdominal and spine).

Several studies have investigated the lifting technique in squats i.e. lifting depth, leg position (see Clark, Lambert, & Hunter, 2012 for a review) and the effects of training interventions, i.e. strength, power and hypertrophy (e.g. de Souza et al., 2010; Hermassi, Chelly, Tabka, Shephard, & Chamari, 2011). However, not much is known about muscle patterning during lifts at sub- maximal loads (6 RM) in the squat exercise. To our knowledge and in contrast to the bench press, no study has examined the kinematic and neuromuscular activation pattern in squats using typical training loads among athletes. In contrast to the bench press, the muscles involved in squats are much bigger and these muscles are also used much more during daily activities that are weight-bearing like walking and running compared to e.g. grasping and writing (Bassey Fiatarone, O'Neill, Kelly, Evans, & Lipsitz, 1992; Reid and Fielding, 2012). Due to these differences in muscle groups and the function of the strength training exercises involved (bench press and squat), this could result in less change in muscle activation and kinematics in squats during sub-maximal loads. The information gained about the muscle patterning and performance during 6 RM in squatting can help coaches and athletes with their training planning since athletes perhaps only need to perform four repetitions at 6 RM load to avoid changes in muscle patterning. Therefore, the purpose of this study was to investigate the muscle patterning and 6-RM performance in two-legged, free-weight squatting in experienced resistance-trained athletes. We hypothesise the same as was found in the study by van den Tillaar & Saeterbakken (2013) for the bench press: an increased EMG amplitude of the prime movers, increased total lifting time and decreased maximal velocity.

MATERIAL AND METHODS

Participants

Fifteen healthy resistance-training experienced males (age 24 ± 4 years, body mass 82 ± 11 kg, height 179 ± 6 cm, experience 6 ± 3 years) participated in the study. None of them were competitive power- or weightlifters. Inclusion criteria were to be able to lift 1.5 times' their own bodyweight in a 1 RM squat (femur parallel to the floor) and to be without any injuries or pain which could reduce their maximal performance. The subjects did not conduct any resistance training of the legs 72 hours before testing. The study complied with the requirements of the regional Committee for Medical Research Ethics and conformed to the latest revision of the Declaration of Helsinki. Each subject was informed of the testing procedures and possible risks, and written consent was obtained prior to the study.

Procedures

Two familiarisation tests were performed two weeks before the experimental test. In the first familiarisation test, a subject positioned their feet in their preferred pose in which the position of the feet was measured. This position was then controlled and was identical in every subsequent session. Then the lower position (defined as 80 degrees in the knee joint, full extension defined as 180 degrees) was found using a protractor. A horizontal rubber band was used to identify this lower position during the tests which the subjects had to touch with the proximal part of their hamstring before starting the upwards movement.

The 6-RM load was estimated by the subjects in the first familiarisation test. Subjects reported their estimated 6 RM and 95% of this load was used for performing the six repetitions. In the second familiarisation test, testing started at the 6 RM achieved in the first familiarisation session. The load was increased or decreased by 2.5 kg or 5 kg until the real 6 RM was obtained (1–3 attempts). Rest lasting between three to five minutes was given between each attempt (Goodman, Pearce, Nicholes, Gatt, & Fairweather, 2008). In the experimental test, the 6-RM load achieved in the second familiarisation session was used. The subjects performed a standardised progressive specific warm-up protocol according to the same protocol used by Paoli, Marcolin, & Petrone (2009) and Saeterbakken & Fimland (2013a). After a general warm-up on a treadmill or cycle, it consisted of 15 repetitions at 30%, 10 repetitions at 50% and 6 repetitions at 80% of 6 RM in squatting.

The 6 RM squats were performed with an Olympic barbell (2.8 cm diameter, length 1.92 m) in a power rack (Gym 2000, Modum, Norway). The subjects bended in a self-paced but controlled tempo from full-knee extension until the back of their thigh touched the rubber band. They then received a verbal signal from the test-leader and returned to the starting position as quickly as possible.

Measurements

EMG activity was measured of the vastus lateralis, vastus medialis, rectus femoris, biceps femoris and erector spinae (L1, 6 cm lateral to the spinous process) muscles. The skin was shaved, abraded and cleaned with alcohol before placing the gel-coated self-adhesive electrodes (Dri-Stick Silver circular sEMG Electrodes AE-131, NeuroDyne Medical, USA). The electrodes (11 mm contact diameter and a 2 cm centre-to-centre distance) were placed on the dominant leg along the presumed direction of the underlying muscle fibre according to the recommendations of SENIAM or similar studies (Hermens, Freriks, Disselhorst-Klug, & Rau, 2000; Saeterbakken and Fimland, 2012; 2013). To minimise noise from the surroundings, the raw EMG signal was amplified and filtered using a preamplifier located close to the sampling point. The preamplifier had a common mode rejection ratio of 100 dB, high-cut frequency of 600 Hz and low-cut frequency of 8 Hz. The EMG signals were converted to root mean square (RMS) EMG signals using a hardware circuit network (frequency response 0–600 kHz, averaging constant 100 ms, total error ± 0.5%). Finally, the RMS-converted signal was sampled at 100 Hz using a 16-bit A/D converter. Commercial software (MuscleLab V8.13, Ergotest Technology AS, Langesund, Norway) was used to analyse the stored EMG data. The beginning and end of each of the six repetitions was identified by using a linear encoder (ET-Enc-02, Ergotest Technology AS, Langesund, Norway) connected to the barbell. It measured the lifting time of the downward and upward part of the barbell of each repetition of the 6-RM test with a resolution of 0.075 mm and counted the pulses with 10 ms intervals. Peak and average velocity of the barbell during the downward and upward parts was calculated using a five-point differential filter with the Musclelab V8.13 software (Ergotest Technology AS, Langesund, Norway) together with the mean EMG RMS activities during these two parts during each repetition (i.e. short stops at full leg extension were removed from the analysis). The linear encoder was synchronised with the EMG recordings using a Musclelab 4020e and analysed with V8.13 software (Ergotest Technology AS, Langesund, Norway).

Statistical Analysis

To assess differences in kinematics during the 6-RM, two-legged, free-weight squats testing, a one-way ANOVA with repeated measures (repetition: 1 to 6) was used with Holm-Bonferroni post-hoc tests. To assess differences, EMG activity during the downward and upward parts of the 6-RM squats, a two-way ANOVA 2 (downward vs. upward part) x 6 (repetition: 1 to 6) repeated measures was used. If significant differences were found for the variable repetition, a one-way ANOVA with repeated measures for the downward and upward parts was performed with Holm-Bonferroni post-hoc tests. In cases where the sphericity assumption was violated, the Greenhouse-Geisser adjustments of the p-values were reported. The level of significance was set at $p \leq 0.05$. For statistical analysis purposes, SPSS version 21.0 (SPSS, Inc., Chicago, IL) was applied. All results are presented as means ± standard deviations and effect size was evaluated with η^2_p (partial Eta squared) where $0.01<\eta^2<0.06$ constitutes a small effect, a medium effect when $0.06<\eta^2<0.14$ and a large effect when $\eta^2>0.14$ (Cohen, 1988).

RESULTS

A significant change in total lifting time (F=4.58, p=0.014, η^2=0.24) was found from the first to the sixth repetition (Figure 1). The post-hoc comparison showed that the total lifting time was significantly lower in repetitions 2 and 3 compared with all of the later repetitions. However, when the total lifting time was divided between the downward and upward parts, the lifting time in the downward part (F=4.49, p=0.001; η^2=0.24) significantly decreased from repetition 1 to 2 and then only significantly increased again between repetition 2 and 6. In the upward part (F=4.37, p=0.038; η^2=0.24), the lifting time increased significantly from repetition 4 (Figure 1). The average and peak velocity also changed significantly over the six repetitions (F≥4.78, p≤0.001; η^2≥0.26). The peak velocity significantly increased in the downward part from repetition 1 to 2 and was relatively similar from repetition 2 to 6 (Figure 2). However, the average downward velocity was significantly higher in repetition 1 compared with repetitions 2–4 and lower in repetition 2 compared with 6 (Figure 2). In the upward part, the peak upwards velocity decreased significantly from 2 to 4 and reduced further for each repetition after. However, when the average upward velocity was calculated, the velocity decreased significantly in each repetition from 4 to 6 (Figure 2).

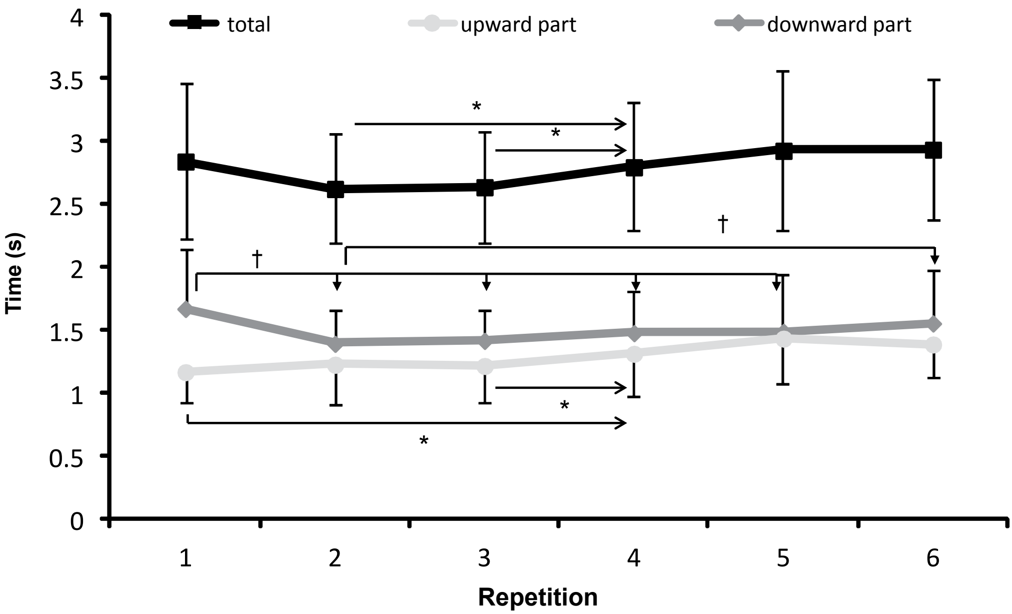

Figure 1. Mean (SD) in lifting time in the downward and upward part together with the total lifting time of each repetition during 6-RM, two-legged free-weight squats.

*indicates a significant difference between this repetition and all repetitions away from the sign, $p \leq 0.05$.

† indicates a significant difference between these repetitions on a $p \leq 0.05$ level.

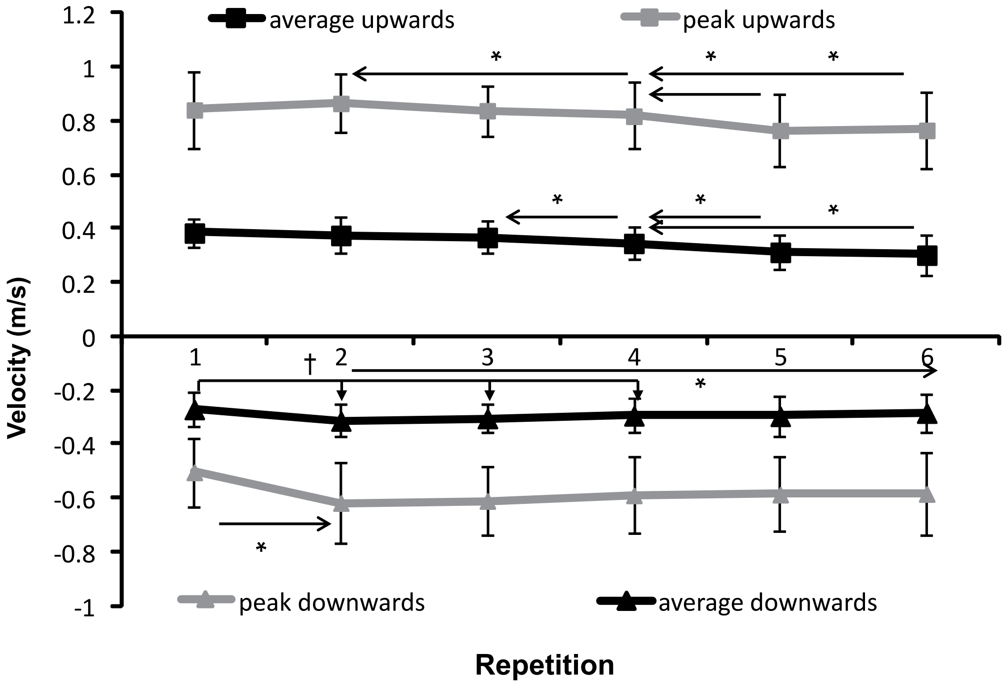

Figure 2. Mean (SD) peak and average velocity for each repetition in the downward and upward part during 6-RM, two-legged free-weight squats.

*indicates a significant difference between this repetition and all repetitions away from the sign, $p \leq 0.05$.

† indicates a significant difference between these repetitions on a $p \leq 0.05$ level.

While the absolute and relative time of the occurrence of the downward peak increased significantly ($F \geq 4.66$, $p < 0.001$; $\eta^2 \geq 0.25$) from repetition 3 to 4 and 4 to 5, the absolute and relative time of the occurrence of the downward peak velocity did not significantly change during the six repetitions ($F \leq 0.87$, $p \geq 0.50$; $\eta^2 \geq 0.06$) and occurred at around 30% of the lowering time (Figure 3).

The EMG activity was significantly higher for all muscles in the upward part compared with the downward part ($F \geq 6.89$, $p \leq 0.002$; $\eta^2 \geq 0.33$). In the downward part of the squats, the repetition x muscle interaction was significantly different for all muscles ($F \geq 3.65$, $p \leq 0.041$; $\eta^2 \geq 0.21$). The post-hoc comparison showed that the EMG activity of the vastii, rectus femoris and biceps femoris muscles increased significantly from repetition 1 to 2 while it increased from 1 to 3 for the erector spinae muscles. Further, for the vastus lateralis and biceps femoris (Figure 4) the muscle activity increased again from repetition 2 to 6, and from repetition 3 to 6 for the erector spinae (Figure 4).

In the upward part, the muscle EMG activity increased significantly for all of the muscles ($F \geq 5.52$, $p \leq 0.003$; $\eta^2 \geq 0.28$). The post-hoc comparison showed that the EMG activity of all muscles increased significantly from repetition 1 to 3 (Figure 4). The muscle activity increased significantly for the biceps femoris and erector spinae muscles from repetition 2 to 3, for the vastus lateralis from 2 to 4, and for the rectus femoris from repetition 2 to 6 (Figure 4).

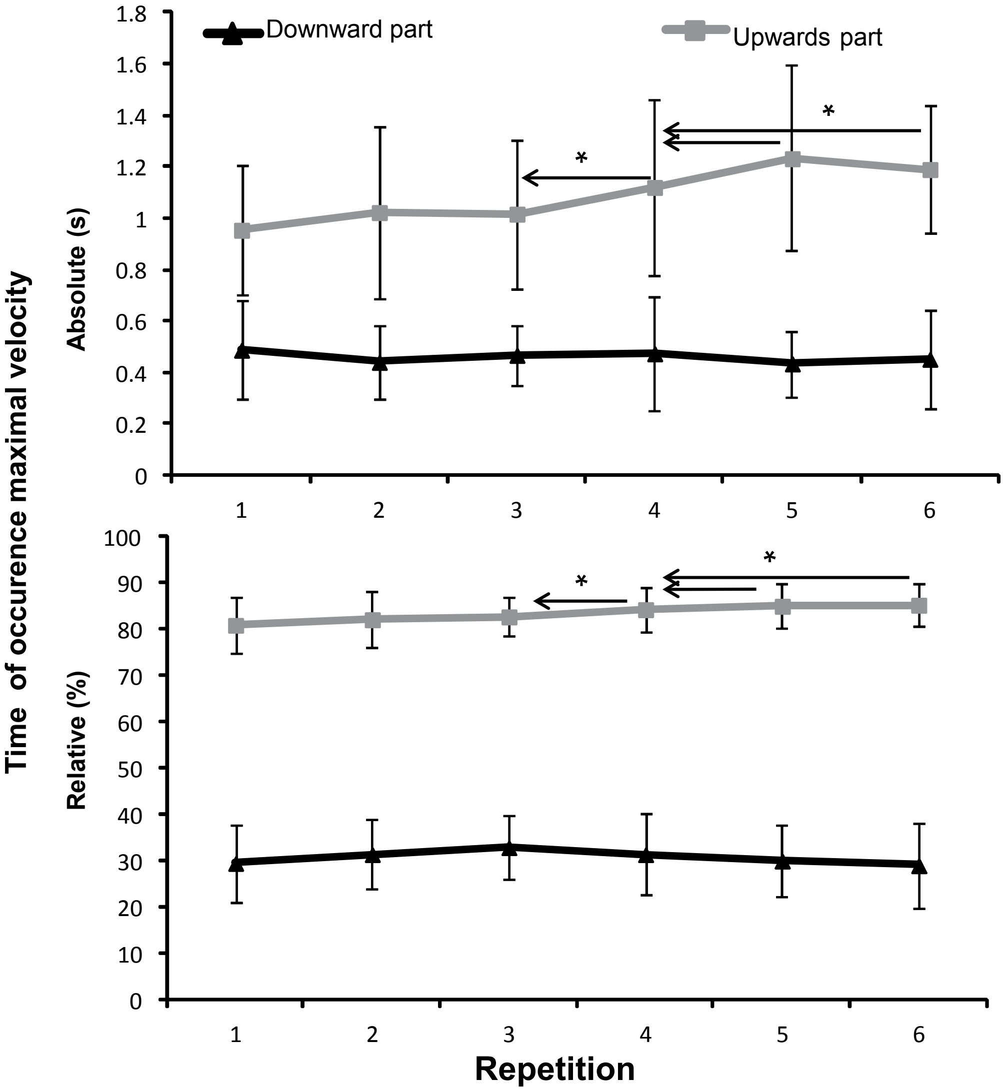

Figure 3. Mean (SD) absolute and relative time of occurrence of the peak velocity during the downward and upward part of 6-RM, two-legged free-weight squats.

*indicates a significant difference between this repetition and all repetitions away from the sign, $p \leq 0.05$.

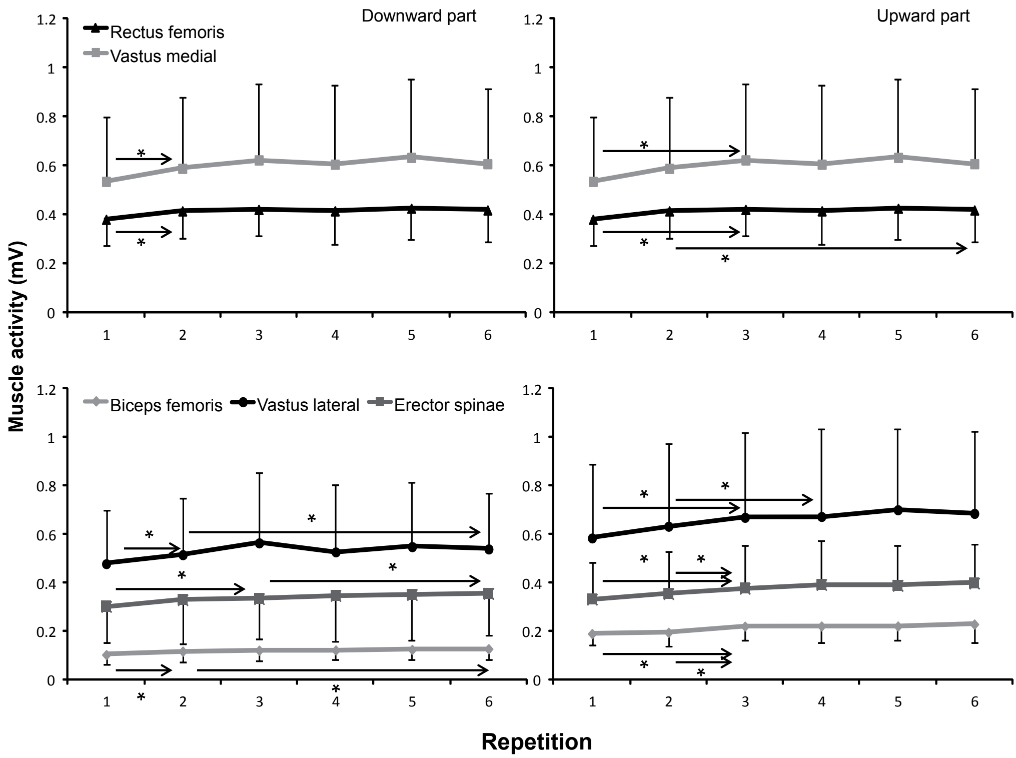

Figure 4. Mean (SD) root mean square (RMS) EMG activity for each repetition of the downward and upward part in vastus lateralis, vastus medialis, rectus femoris, biceps femoris and erector spinae during 6-RM, two-legged free-weight squats.

*indicates a significant difference between this repetition and all repetitions away from the sign, $p \leq 0.05$.

DISCUSSION AND CONCLUSION

The aim of this study was to compare the 6-RM performance and muscle activation for each repetition during two-legged, free-weight squats. The main findings were that the total lifting time increased, but only from repetition 2 and 3 to 4 and later. As a consequence, the peak and average velocity in the upward part decreased, especially after repetition 3. For the downward part, only repetition 1 showed significantly longer lifting times and lower peak velocity during the six repetitions. Generally, EMG activity increased from repetition 1 to 2–3 and was stable thereafter in the upward part.

Several studies have investigated the effect of numerous factors like stance width, squat depth, weight belt instability etc. on kinematics and muscle activation in squats (Clark, Lambert and Hunter, 2012). However, very little is known about kinematics and muscle patterning during sub-maximal lifts in squats. Only Smilios, Häkkinen, & Tokmakidis (2010) showed increased quadriceps activity, but similar biceps femoris activity during four sets of 20 repetitions at 50% 1 RM in squats. In addition, they observed a decrease in power output in sets 3 and 4. However, performing 20 repetitions per set is not a recommended approach for gaining strength or hypotrophy (ASCM position stand, 2009) which makes it difficult to compare these results with the present ones. To the best of our knowledge, no earlier studies of squatting reported kinematics and muscle activation during sub-maximal lifts in contrast to bench presses (van den Tillaar & Saeterbakken, 2013; 2014). The bench press and squatting thus show many similarities since both exercises involve multi joints with large muscles and both exercises are main exercises in strength training: one for the upper and the other for the lower limbs. Therefore, the findings of the present study are mainly compared with the findings for bench press. Eventual differences can be explained by the different sizes and function of the muscles involved.

In the present study, the total lifting time is lower in repetitions 2 and 3 compared to the later repetitions (Figure 1), which is chiefly caused by the increased time in the upwards part which increased from repetition 4. This is not in line with findings for 6-RM bench press (van den Tillaar & Saeterbakken, 2014) in which the upward lifting time increased from repetition to repetition, indicating that fatigue occurs. In the current study, only the lifting time upward part increased significantly from repetition 4. These differences in lifting time upwards may be explained by the muscle size and function between the two studies. In the upper body, the muscle size involved is much smaller than in the lower body, which can result in earlier fatigue of the muscles. Moreover, the functions of the muscles involved differ: in the upper body mainly the muscles are involved in small discrete movements like grasping, catching etc. without bearing heavy loads, while in the lower body the primary function of the muscles is for bearing and locomotion. This speculating is supported by Paulsen, Myklestad, & Raastad (2003) who demonstrated a similar strength increase when training 1 or 3 sets for the upper body in contrast to the lower strength increase when training the same (1 vs. 3 sets) for the lower body. Further, when comparing absolute loads between the upper and lower body, the lower body is superior in lifting loads. As a result, the muscles in the lower body are probably less affected by the rate of fatigue compared to the upper body, which is supported by the higher percentage of 1 RM in 6 RM (85 vs. 81%) in bench press than in squatting (Baechle & Earle, 2008).

The difference in upwards lifting time is linked to the lower average lifting velocity and the time of occurrences of the peak velocity in the upward part. This changed markedly from repetition 4 and later (Figures 2 and 3); i.e. the peak and average velocity decreased and the time of occurrence of the peak velocity increased. This clearly indicates that something happens from repetition 4 and later. However, no explanation could be given by the observed muscle behaviour as no changes in EMG activity occurred from repetition 4 and subsequently. It can therefore be speculated that reduced ATP intra muscular and keratin phosphate may be attributed to the lower peak and average lifting velocity (Hargreaves et al., 1998; McLester, 1997). Comparing EMG activity, the main differences occur from repetitions 1 and 2 compared with the rest, i.e. the lower activation of most muscles in repetitions 1 and 2 compared with the other repetitions (Figure 4). This was also observed in the downward part of the squat in time, velocity and muscle activation (Figure 1–4). In particular, repetition 1 was different from the rest (Figure 1–4). The lowering time was longer (Figure 1), which was caused by the lower average and peak velocity (Figure 2), which again was the result of lower activation of the muscles involved (Figure 4). This lower activation in the downward part probably also influenced the muscle activity in the upward part due to the lower potentiation of the contractile system by the lower stretch action (Herzog et al., 2006; van den Tillaar & Ettema, 2010) as shown by the lower activity in the upward part during the first repetition (Figure 4) and it is therefore able to perform better for a short while, i.e. produce more force during the early shortening period.

This phenomenon was also observed in 6-RM bench pressing (van den Tillaar & Saeterbakken, 2014). Van den Tillaar & Saeterbakken (2014) explained this by stating that the athlete in the first repetition has to elaborate the weight to be lifted to be sure that they have control over the weight during the exercise. After this first repetition, the athlete knows the effect of the weight on the lifting technique and they can thereby increase the lowering velocity. Due to increased lowering velocity, the muscles have to compensate by increasing the activities to decelerate the barbell closer to the lowest point. This again results in a higher activation at the start of the upward movement of the squat in the next repetition (Figure 4).

All of the measured muscles showed an increase in EMG activity during the six repetitions, which is probably caused by fatigue. Since the lifts were at sub-maximal level, the muscles had the possibility to increase EMG activity (varying from 10 to 23%) during the repetition, which was also observed in 6 RM in bench press (van den Tillaar & Saeterbakken, 2013; 2014). This was likely due to the increased central drive and thereby increased motor unit recruitment (Smilios, Häkkinen, & Tokmakidis, 2010). However, McBridle, Larkin, Dayne, Haines, & Kirby (2010) and Smilios, Häkkinen, & Tokmakidis (2010) showed that this is not always the case in squats for all muscles involved. McBridle, Larkin, Dayne, Haines, & Kirby (2010) showed that by lifting with a higher intensity (higher percentage of 1 RM: 70 to 90%) EMG activity did not increase significantly for the vastus lateralis (1.3%), while it increased by 14% for the biceps femoris. Smilios, Häkkinen, & Tokmakidis (2010) showed the opposite, namely that the EMG activity of quadriceps at 80% of 1 RM decreased by around 8%, while the biceps' EMG activity did not change at 80% of 1 RM after inducing fatigue. The discrepancy between the findings is most likely the result of the different protocols used, which therefore calls for more investigation.

There are some limitations of our study. First, the present study was limited by dividing the squat only into two phases, which did not give detailed information about the patterning in different stages of the selected muscles during the whole exercise. Second, the muscle activity of the glutei muscles was not measured. These muscles are responsible for the hip extension during the lift. These muscles could be influenced in the same or another way as the other muscles, which was important for the total performance. However, it was not possible in the current setting to measure those muscles. In a future study, those muscles should be included to allow a better understanding of the squat during the several repetitions. Third, only healthy resistance-trained participants were recruited. Thus, the results cannot necessarily be generalised to other populations like elite power lifters. Lastly, we did not measure the EMG median frequencies. Walker, Davis, Avela, & Häkkinen (2012) showed that with sub-maximal loading in the leg press the median frequency decreases while the EMG amplitude increases. Due to the limitations of the software used in the present study, we were unable to measure the median frequencies of the muscles. In future studies this should be investigated to gain a more detailed view about muscle behavior in the squat during successive repetitions.

In conclusion, our study indicates that in a 6-RM, two-legged free-weight squat protocol performance decreases, but mainly from repetition 4 and later (lower barbell velocities and longer lifting times). However, the EMG amplitude of the prime movers only increased mainly from repetitions 1 and 2 in addition to similar muscle activity in the final four repetitions, which indicates maximal activity in those repetitions. By avoiding fatigue measured by the lower barbell velocity in the final repetitions, thus decreasing the number of repetitions from 6 to 3 or 4 with the same intensity, the number of sets performed in each session may be increased. This may result in a greater training volume and frequency without the negative effect of fatigue (Sanchez-Medina

& Gonzalez-Badillo, 2011). We therefore recommend only performing four of the six repetitions with the 6 RM load for athletes to gain muscle strength.

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