



Research Article

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## The Influence of Self-Myofascial Release on Countermovement Jump Force-Time Variables in Pre-Elite Academy Rugby Union Players

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### Abstract

**Objectives:** The aim of this study was to examine the influence of a 20 min lower-body self-myofascial release (SMFR) protocol on countermovement jump (CMJ) performance and CMJ force-time variables in pre-elite Rugby Union players, and to assess if differences exist between groups; forwards vs. backs.

**Design:** Pre-elite male Rugby Union academy players (n=20) volunteered for the study and were categorized as forwards (FWD) or backs (BK). Testing occurred in a sequenced mixed design involving TEST (repeated; Control vs. SMFR) and GROUP (FWD vs. BK).

**Methods:** Irrespective of player position, all subjects completed baseline assessments consisting of dynamic warm-up (DYN) and 6 CMJs, followed by 20 min complete rest, then 10 min lower-body SMFR protocol, and subsequent DYN and CMJ re-test. Participants performed the SMFR exercises to 9 various sites over the lower extremities on both sides of the body. The data from the best 3 jumps relative to jump height were averaged and used for analysis.

**Results:** The SMFR had no significant effect on CMJ height for GROUP ( $p=0.139$ ). Significant differences in concentric force were found for GROUP ( $p=0.004$ ) and TEST ( $p=0.04$ ). For eccentric rate of force development (RFD) there was a significant effect for TEST ( $p=0.008$ ). For concentric impulse there was a significant difference for GROUP ( $p=0.016$ ).

**Conclusion:** The SMFR protocol combined with DYN affected CMJ force-time variables positively without deteriorating jump height in pre-elite academy Rugby Union players. Strength and conditioning coaches can prescribe SMFR with DYN prior to training and competition in Rugby Union to enhance force production capabilities in dynamic multi-joint movements without negatively affecting an individual performance.

### Keywords

Muscular power; Neuromuscular; Force production; Performance

### Introduction

Fascia is the tough connective tissue that surrounds every structure of the body, including all bones, muscles, organs, nerves and blood vessels, from tissue to the cellular level. Myofascia is the outer layer of muscle, providing support, stability, and cushioning, while contributing to locomotion and dynamic flexibility [1]. Today, the training and game demands on Rugby players at the pre-elite/elite level are high, resulting from a combination of high intensity running [2], total running meters [3], and impact trauma suffered during a match [4]. Trauma, injury and inflammation – such as that induced from the cumulative physiological and psychological effects of game and training demands for a pre-elite/elite rugby player – may cause the fascial system to malfunction and adhere to surrounding structures, resulting in abnormal pressure on organs, bones, muscles, or nerves [5]. Such a protective mechanism can cause fibrous adhesions to form, creating pain and dysfunction throughout the body potentially leading to altered structural alignment, poor muscular biomechanics, and decreases in range of motion (ROM), strength, force production, motor performance and endurance [1]. Ultimately, if myofascial constraints are present, the athlete may lose functional capacity, experience pain and potentially develop compensatory movement patterns, all of which may be detrimental to performance, training intensity [6] and injury risk [7].

Today, foam rolling (FR) – a type of self-myofascial release (SMFR) – is commonly used amongst professional rugby teams and other sporting teams and therapists alike as a means of treating soft tissue and fascial restrictions [8]. Through FR, it has been suggested that individuals could potentially correct muscular imbalances, alleviate muscle soreness, relieve joint stress, improve neuromuscular function and increase ROM [1]. To date however, minimal evidence exists on the effects of SMFR on dynamic force production capabilities. Examining an athletes' force profile is an effective method to monitor neuromuscular performance, movement competency and/or fatigue [9]. Over the years, vertical jump (VJ) testing has become a popular method among coaches and sports scientists as a means of assessing neuromuscular performance [10] and explosive power of the lower limbs [11]. Temporal phase analyses of the power-, force-, velocity- and displacement-time curves throughout the entire propulsive phase of a countermovement jump (CMJ) is steadily becoming the preferred performance monitoring method for sporting teams and athletes alike [9,12,13]. If fascial restrictions are present, such a screen may assist in identifying any related movement restrictions and/or reduced force production capabilities. Consequently, the purpose of this study was to examine SMFR use via analysis of high quality neuromuscular performance screens, and thus determine the effectiveness SMFR has on neuromuscular performance. The study also assessed the influence of player type/position, and hence anthropometric profile, on the influence of SMFR to CMJ force-time data.

### Methods

Twenty healthy male subjects from a professional Rugby Union U20s Academy volunteered for the study, and were separated into 2 groups based on playing position; backs (BKs) and forwards (FWDs) (Table 1). Subjects were asked to maintain a normal diet and training regime throughout the duration of the study. Physical activity

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**Table 1:** Subject characteristics.

Subjects	Position	Age	Height	Weight	BMI
N = 11	Backs	19 ± 0	181.1 ± 4.2	85.6 ± 6.3	26.1 ± 1.5
N = 9	Forwards	18.7 ± 0.7	189.7 ± 3.3	106.9 ± 3.3	29.8 ± 3.2

readiness and injury history questionnaires were administered for all subjects prior to participation in the study. The research was approved by the Human Research Ethics Committee of the support university. All subjects involved in the study provided informed written consent prior to data collection. Following consent, subjects reported to the professional rugby team’s High Performance Centre for all testing. Subjects’ height and weight were assessed using a stadiometer and Kistler force platform respectively. Body Mass Index (BMI) was also calculated as weight (kg) divided by height squared (m<sup>2</sup>).

A two group mixed (between-within) design was used to examine the influence of SMFR to the lower extremities on the following dependent variables: CMJ height (CMJ-Ht), eccentric rate of force development (ECC-RFD), concentric force (CON-F), jump height (JHt) and concentric impulse (CON-IMP). The between group factor was player POSITION (BKs vs. FWDs), and the repeated factor was TEST (pre- vs. post). The experimental day consisted of baseline CMJ testing, followed by a 20 min period of complete rest, a SMFR intervention, and then immediate CMJ re-test. Subjects underwent one session of testing. All testing sessions took place in the one location, and were supervised by the same investigator. Care was taken to ensure all subjects received the same verbal instruction and encouragement for all tasks to negate potential differences in arousal. Each test was conducted in the following order:

Dynamic Warm-up > CMJ Protocol > 20 min rest > SMFR Protocol > Dynamic Warm-up > CMJ Protocol

Subjects were shown and instructed to follow the directions of a video consisting of one round of dynamic stretches, including 10 reverse lunges with arms overhead, 10 lateral lunges, 10 bodyweight good mornings, then 2 rounds of basic plyometric exercises including, 10 pogo hops, 5 squat jumps, and 5 tuck jumps. Immediately following the dynamic warm-up, subjects were required to perform 6 CMJ with

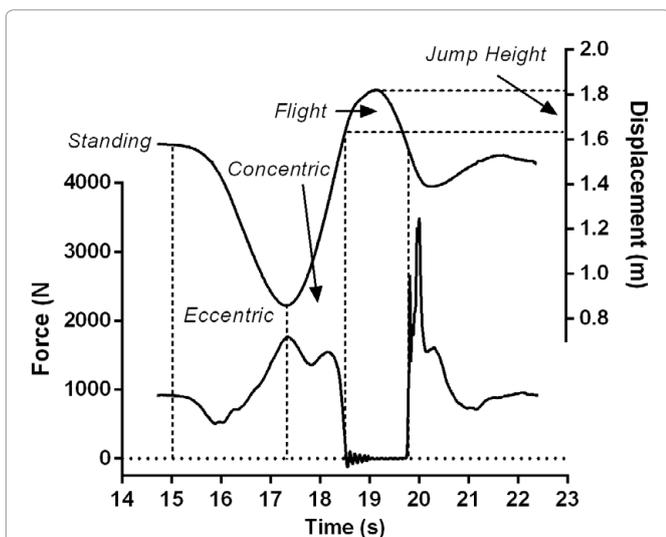
20 seconds rest between jumps. A CMJ with self-selected depth of countermovement and including arm-swing was used to gain an insight to the athlete’s natural force production variables when unaffected by jumping parameters and external cues, which may reflect their true force production capabilities during an uncontrolled environment, such as a game of Rugby Union. Additionally, it has been shown that in skilled jumpers, subjects chose the countermovement depth that maximized both peak force and peak velocity resulting in maximal power output [14]. Each subject set up for the CMJ in a standing position, dropped into the squat position, and then immediately jumped as high as possible. Subjects were instructed to jump as high as possible following a digital cue. After each jump, jump height was calculated from impulse momentum and shown to the subject in an attempt to keep motivation and arousal consistent.

Participants performed the SMFR exercises over the lower extremities only. They were instructed to perform 30 seconds of SMFR to 9 various sites on both sides of the body (Table 2). A golf ball (Top Flight, XL2000) was used on the plantar fascia because of its size and rigidity. The foam roller used in the study was chosen because it was the same model used by the Professional Rugby Team on a regular basis. Lastly, a lacrosse ball (IronEdge) was used to release the gluteal muscles and tensor fasciae latae (TFL).

All CMJ testing was performed with participants standing on a 0.6 x 0.5m Kistler piezoelectric force platform (9260AA6; Kistler Group, Winterthur, Switzerland) with a sampling frequency of 1000 Hz. The data from the best 3 jumps relative to CMJ-Ht were averaged and used for analysis. The dependent variables were the CMJ-Ft variables extracted from the CMJ-Ft curve including ECC-RFD, CON-F, and CON-IMP. Figure 1 indicates center of mass displacement and the corresponding ground reaction forces during a countermovement jump. Data was first compiled in a commercial spreadsheet program (Excel; Microsoft Corporation, Seattle, WA; v2011), and then imported into a commercial statistical package program for all statistical analyses (SPSS v20; IBM Corporation, USA). Data for ECC-RFD, CON-F, CON-IMP and JHt were analyzed by a mixed design (POSITION [BKs vs. FWDs] x TEST (pre vs. post)) 2 way ANOVA. Mean data was entered into a commercial graphics program for all

**Table 2:** SMFR protocol and instructions.

	Instrument	Site	Instruction
1.	Golf Ball	Sole of foot	With shoes off, use body weight to press golf ball into sole of foot. Focus towards tight, tender areas.
2.	Foam Roller (Black)	Calf	Sit on ground, legs outstretched and crossed over foam roller, while propped up on your hands. Use your arms to move over the roller from ankle to knee – pass across outer, middle and inner calf. Hold still on tight, tender spots and move foot up and down.
3.	Foam Roller (Black)	Shin	In a kneeling position and propped on hands, cross feet underneath you, and lower outer, meaty part of shin onto the roller. Using your arms, move over the roller from ankle to knee. Hold still on tight, tender spots and move foot up and down.
4.	Foam Roller (Black)	Outer Quad	Lying on your side, propped up on your hands and elbows, and free leg stabilizing in front. Pass the outer, lower third of the quad over the roller. Pause at tight, tender areas, and flex/extend the knee.
5.	Foam Roller (Black)	IT Band	Lying on your side, propped up on your hands and elbows, and free leg stabilizing in front. Pass the outside upper leg over the roller from knee to hip. Pause at tight, tender areas, and flex/extend the knee.
6.	Foam Roller (Black)	VMO	Lying on your front, propped up on your hands and elbows, free leg out straight. Flex the hip of the involved limb so knee is at hip height out to the side, place roller above the knee, and roll across the bottom third of the muscle. Pause at tight, tender areas, and flex/extend the knee.
7.	Foam Roller (Black)	Groin	Lying on your front, propped up on your hands and elbows, free leg out straight. Flex the hip of the involved limb so knee is at hip height out to the side, place roller well above the knee, and roll across the upper inner thigh.
8.	Lacrosse Ball (Red)	High Glute	Sit with feet flat on floor and knees close to chest, cross one foot over the knee, and then prop up onto your hands. On the side with the foot up, place lacrosse ball above your butt-cheek, at the pants/waist-line level, and roll from side to side.
9.	Lacrosse Ball (Red)	Hip Flexor	Lie on side in fetal position, place lacrosse ball between to floor and the fold at your hip. On tight, tender areas oscillate the ball.



**Figure 1:** Indicates center of mass displacement and the corresponding ground reaction forces during a countermovement jump.

figure development (Prism; GraphPad Software, Ventura, CA; v6). All results are reported as mean ± SD, and statistical significance was accepted at  $p < 0.05$ .

## Results

CMJ-Ht revealed no significant differences for GROUP ( $p=0.139$ ), TEST ( $p=0.391$ ) and the GROUP x TEST interaction ( $p=0.419$ ). CON-F revealed a significant difference for GROUP ( $p=0.004$ ), TEST ( $p=0.04$ ) and a non-significant GROUP x TEST interaction ( $p=0.225$ ). CON-F improved significantly across both groups following SMFR. ECC-RFD revealed a non-significant difference for GROUP ( $p=0.074$ ), a significant effect for TEST ( $p=0.008$ ) and a non-significant GROUP x TEST interaction ( $p=0.537$ ). The SMR protocol induced significant improvements of ECC-RFD in both backs and forwards and across the whole group, although no significant differences were found between player positions. CON-IMP results revealed a significant difference for GROUP ( $p=0.016$ ), and non-significant effects for TEST ( $p=0.28$ ) and GROUP x TEST interaction ( $p=0.212$ ).

## Discussion

The main findings from the present study indicate that SMFR is effective in improving certain variables of neuromuscular performance. SMFR is beneficial for enhancing CON-F. Forwards and backs differed on CON-F, though both groups responded similarly to the SMFR. The ECC-RFD increased significantly following SMFR across the group as a whole and within groups, although no positional variances were found. On the other hand, CON-IMP showed only significant differences between player positions. Despite most measures of neuromuscular performance showing improvement, JHt did not increase following SMFR. Additionally SMFR did not appear to acutely impede athlete performance, a finding consistent with previous literature [15,16].

While the present study obtained JHt measures using force profile data, all previous research examining the effects of SMFR used a vertical jump (VJ) test to obtain JHt. MacDonald et al. [17], and Peacock et al. [18] all found no change in CMJ-Ht when using a countermovement following 1 – 2 minutes of SMFR on various lower

limb muscles. One conflicting study by Peacock et al. [16] found that 30s of SMFR on various lower limb muscles significantly ( $P=0.012$ ) increased VJ performance using a countermovement. Interestingly, SMFR was used in combination with a dynamic warm-up, much like the protocol used in the current study. The authors' contributed the results in part to the physiological enhancements of fiber pattern recruitment and related movement capabilities associated with MFR; effects which were likely amplified when combined with dynamic movements. While the results showed no improvements in JHt, it should be noted that no decrements were evident. Finally, it is worth noting that CMJ computation of JHt may be less valid than direct measures as done through VJ testing. It remains unclear whether the computations used in the commercial force platform equipment and software of this study requires further validation.

CON-F represents the average VGRF relative to bodyweight generated throughout the concentric phase of a VJ. CON-F indirectly represents an athlete's relative strength and movement competency, as it demonstrates the ability to transfer eccentric energy to concentric [18,19]. Additionally this demonstrates how CON-F may fluctuate between player position differences in rugby, thus supporting player position variations in force production found in the present study while highlighting its worth in CMJ force profiling. Previous research has only examined single-joint muscle force production (i.e. maximal voluntary isokinetic knee extension forces at  $90^\circ$ [17,20]), all of which found no substantial fluctuations in performance. Our results support the theory made by MacDonald et al. [17], in that SMFR may not affect isokinetic and isometric measures of single-joint muscle performance. SMFR does however seem to substantially benefit the force production capabilities of dynamic multi-joint movements. We cannot confirm that the improvement was due to either decreased muscle soreness or increases in ROM as MacDonald et al. [17] theorized, since such measures were not obtained in the present study. However, prevailing evidence confirms the positive effects of SMFR on flexibility and joint ROM measures such as knee extension ROM [17], sit and reach [18,21,22], and a weight bearing lunge test [23]. While the exact mechanism(s) SMFR benefits remain unknown, the most likely are thought to be neurophysiological [23], relating to Ruffini and Pacini corpuscles and interstitial muscle receptors (mechanoreceptors) commonly found in fascia [22]. Pressure applied to mechanoreceptors may stimulate the nervous system and lead to reduced muscular tension [24], which might cause an immediate increase in stretch tolerance. This increase could potentially account for the acute improvements observed in flexibility and joint ROM following a bout of SMFR [23]. Enhanced free joint ROM may then lead to a minimized eccentric phase (i.e. shorter duration) increasing ECC-RFD due to better utilization of stretch-shortening speed, thus potentially increasing CON-VF [9]. It is interesting though that greater CON-VF did not result in greater JHt, and implies that the relationship between the two needs to be explored further.

ECC-RFD is defined as the slope of the force-time curve during the eccentric phase and is considered an important factor for power production in ballistic movements [19] and a strong predictor of CMJ-Ht [9]. While player position differences were not evident, this does not discredit the use of SMFR as a means of enhancing eccentric force production acutely. Cormie et al. [10] suggested a greater functional ROM may improve CMJ performance due to greater countermovement magnitude; as observed when subjects lowered themselves closer to the ground resulting in maximal ECC-RFD. While improvements in JH were not apparent, this theory may explain in part the increases in ECC-RFD observed in the present

study. As discussed above, the majority of prevailing research shows improvements in joint ROM following acute bouts of SMFR via likely neurophysiological mechanisms. Although we cannot confirm ROM was directly improved, this may be the most likely reason for the significant improvements seen in ECC-RFD via enhanced utilization of stretch-shortening speed [9].

CON-IMP is the relative net vertical impulse produced during the propulsive phase of the CMJ, and is a strong determinant of jump height [25]. The same authors found that increasing countermovement depth decreased peak force though increased jump height and relative net vertical impulse. Thus CON-IMP may provide the most accurate explanation of JHt differences across an array of individuals. Our results support this as no substantial variances occurred in CON-IMP or JHt in PRE or POST groups; however we cannot confirm any variances in countermovement depth as jump technique was uninstructed. PRE and POST measures of CON-IMP for forwards were both significantly greater than PRE and POST measures for backs, respectively. The most likely reason for this is the anthropometric variances that generally exist between forwards and backs in elite Rugby. Specifically, forwards weight more than backs, potentially resulting in deeper fascial tissue manipulation from the SMFR protocol.

## Conclusion

Use of SMFR does not hinder muscle contractile performance during power tasks, and may foster improvement in some aspects of muscle function during power movements. For example, SMFR caused significant improvements in both CON-F and ECC-RFD, with positional variances found in CON-IMP. While the authors cannot confirm that improvements were directly due to acute increases in joint ROM *via* neurophysiological mechanisms, the results justify the use of acute SMFR when combined with a dynamic warm-up prior to exercise as a means of enhancing neuromuscular force production. Research examining the effects of SMFR on ROM and force production variables needs to be undertaken to further understand the mechanisms by which SMFR may improve muscle contractile function during complex movement tasks.

## Practical Implications

- SMFR can be prescribed prior to exercise participation in combination with a dynamic warm-up in order to enhance force production capabilities in dynamic multi-joint movements
- It is unclear whether JHt is directly related to neuromuscular force production capabilities.
- The exact mechanisms of SMFR remain unknown, although they are likely neurophysiological

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## References

1. Barnes M (1997) The basic science of myofascial release: Morphologic change in connective tissue. *J Bodyw Mov Ther* 1: 231-238.

2. Austin DJ, Gabbett TJ, Jenkins DG (2011) The physical demands of Super 14 rugby union. *J Sci Med Sport* 14: 259-263.

3. Roberts SP, Trewartha G, Higgitt RJ, El-Abd J, Stokes KA (2008) The physical demands of elite English rugby union. *J Sports Sci* 26: 825-833.

4. Smart DJ, Gill ND, Beaven CM (2008) The relationship between changes in interstitial creatine kinase and game-related impacts in rugby union. *Brit J Sports Med* 42: 198-201.

5. Barnes JF (2005) Myofascial release. Myofascial Release Treatment Centres and Seminars.

6. Cheung K, Hum PA, Maxwell L (2003) Delayed onset muscle soreness. *Sports Med* 33: 145-164.

7. Cook G, Burton L, Hoogenboom B (2006) Pre-participation screening: The use of fundamental movements as an assessment of function—part 1. *N Am J Sports Phys Ther* 1: 62-72.

8. MacDonald GZ, Penney MD, Mullaley ME, et al. (2013) An acute bout of self-myofascial release increases range of motion without a subsequent decrease in muscle activation or force. *J Strength Cond Res* 27: 812-821.

9. Laffaye G, Wagner P (2013) Eccentric rate of force development determines jumping performance. *Comput Methods Biomech Biomed Engin* 16: 82-8.

10. Cormie P, McBride JM, McCaulley GO (2009) Power-time, force-time, and velocity-time curve analysis of the countermovement jump: impact of training. *J Strength Cond Res* 23: 177-186.

11. MacDonald GZ, Penney MD, Mullaley ME, Cuconato AL, Drake CD, et al. (2004) Reliability and factorial validity of squat and countermovement jump tests. *J Strength Cond Res* 18: 551-555.

12. Laffaye G, Wagner P, Tombleson T (2013) Countermovement jump height: gender and sport-specific differences in the force-time variables. *J Strength Cond Res* 28: 1096-105.

13. Linthorne NP (2001) Analysis of standing vertical jumps using a force platform. *Am J Phys* 69: 1198-1204.

14. Klavara P (2000) Vertical-jump tests: a critical review. *Strength Cond J* 22: 70.

15. Healey KC, Hatfield DL, Blanpied P, Dorfman LR, Riebe D (2014) The effects of myofascial release with foam rolling on performance. *J Strength Cond Res* 28: 61-68.

16. Peacock CA, Krein DD, Silver TT, Sanders GJ, Kyle-Patrick, et al. (2014) An acute bout of self-myofascial release in the form of foam rolling improves performance testing. *Int J Exerc Sci* 7: 202-211.

17. Macdonald GZ, Button DC, Drinkwater EJ, Behm DG (2014) Foam rolling as a recovery tool after an intense bout of physical activity. *Med Sci Sports Exerc* 46: 131-142.

18. Peacock CA, Krein DD, Antonio J, Sanders GJ, et al. (2015) Comparing acute bouts of sagittal plane progression foam rolling vs. frontal plane progression foam rolling. *J Strength Cond Res* 29: 2310-5.

19. Vanezis A, Lees A (2005) A biomechanical analysis of good and poor performers of the vertical jump. *Ergonomics* 48: 1594-1603.

20. Mikesky AE, Bahamonde RE, Stanton K, Alvey T, Fitton T (2002) Acute effects of The Stick on strength, power, and flexibility. *J Strength Cond Res* 16: 446-450.

21. Jay K, Sundstrup E, Søndergaard SD, Behm D, Brandt M, et al. (2014) Specific and cross over effects of massage for muscle soreness: randomized controlled trial. *Int J Sports Phys Ther* 9: 82-91.

22. Sullivan KM, Silvey DB, Button DC, Behm DG (2013) Roller-massager application to the hamstrings increases sit-and-reach range of motion within five to ten seconds without performance impairments. *Int J Sports Phys Ther* 8: 228-36.

23. Beardsley C, Škarabot J (2015) Effects of self-myofascial Release: A systematic review. *J Bodyw Mov Ther* 19: 747-58.

24. Schleip R (2003) Fascial plasticity—a new neurobiological explanation: Part 1. *J Bodyw Mov Ther* 7: 11-19.

25. Kirby TJ, McBride JM, Haines TL, Dayne AM (2011) Relative net vertical impulse determines jumping performance. *J Appl Biomech* 207-14.

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Top

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