

Muscular activity in collegiate football linemen with and without a prefabricated functional knee brace

PROJECT DEFENSE

BY:

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Knee Injury

Knee injuries are one of the most prevalent types of injury in sport

Between 13% and 71% of all injuries occur at the knee joint

Up to 30% of knee injuries involve the anterior cruciate ligament (ACL)

- Medial collateral ligament (MCL) usually involved with ACL injury or second highest occurring knee ligament injury

ACL injury or deficiency leads to decreased stability of the knee joint (increased anterior tibial translation)

MCL injury also decreases joint stability in a valgus position

(Rishiraj et al 2009, Bridge et al 2008)

Knee Braces

Knee braces were originally designed specifically for post-operative and ACL deficient patients

Braces are designed to increase stability of the joint and replicate normal joint mechanics

Numerous categories, designs, and types of knee braces

This study will focus on functional knee braces

(Rishiraj et al 2009, Bridge et al 2008)

Previous research has investigated several parameters

- Injury prevention
- Stabilization
- Performance factors
- Psychological factors
- Muscular activity
- Proprioception

Inconsistent and contradicting findings

Research limitations

(Miller et al 1999, Fantini et al 2013, Palm et al 2012, Beynnon et al 1999)

Electromyography (EMG)

Tool used to study different aspects of muscular activity

EMG amplitude can be affected by various intrinsic and extrinsic variables

Infinite number of ways to analyze EMG data

Comparisons of EMG data is difficult and can result in misinterpretation

Normalization is used to standardize data and allow for more accurate comparison

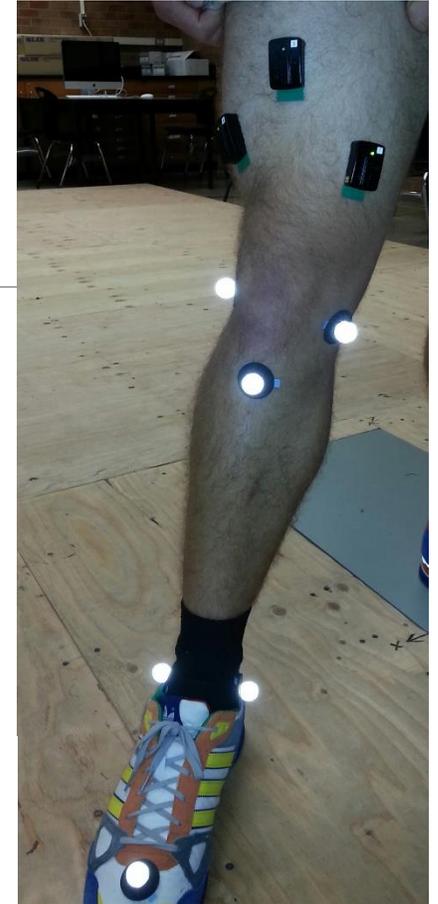
Allows EMG data to be expressed as a percentage of a reference value



Front View



Back View



Purpose

Purpose: To examine muscular activity during sport specific skills in collegiate football linemen with and without a functional knee brace

Hypothesis: Wearing a functional knee brace will affect the muscular activity of the quadriceps and hamstrings, and the maximum vertical GRF experienced

Subjects

Inclusion criteria

- Between 18-26 years old
- Central Washington University football offensive or defensive linemen
- Cannot have undergone knee surgery in the past year

Required paperwork

- PAR-Q
- Exclusion Criteria
- Informed consent

Exclusion criteria

- Muscular, joint, or nervous system disorder that exercise exacerbates
- Any type of metabolic disease (diabetes or thyroid gland disorder etc.)
- Neurological or vestibular disorder
- Severe hypertension at rest (SBP \geq 200mmHG or DBP \geq 110mmHG)

Methods

Subjects were required to report prior to the testing session

- Subjects were fitted for a brace
 - DonJoy Armor FourcePoint functional knee brace
- Dominant leg was determined

Each subject was only required to report for one testing session

Three different skills were chosen to closely replicate real game and practice skills

- 3 point stance
- Lateral Cut
- Depth jump

Each skill was repeated three times twice, once in a brace condition and once in a no brace condition

The subjects were fitted with EMG electrodes

Each subject was allotted 5 minutes to stretch and warm up prior to testing

30 seconds of rest were allowed between each repetition, 5 minutes of rest were allowed between skills, and 10 minutes of rest were allowed between each condition



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The skills

Each skill was explained and demonstrated to the athletes prior to completion

3 point stance

- The subject will get into a 3 point stance (one hand down on the ground as though lining up for a play)
- Feet will be shoulder width apart and staggered (dominant leg behind)
- At the sound of a buzzer they will run forward explosively and continue to run ~3 meters
- Subject will land on the force plate with the catching (dominant) leg (the leg that started farther back)

<http://www.youtube.com/watch?v=gjx85k00pFo>

Depth jump

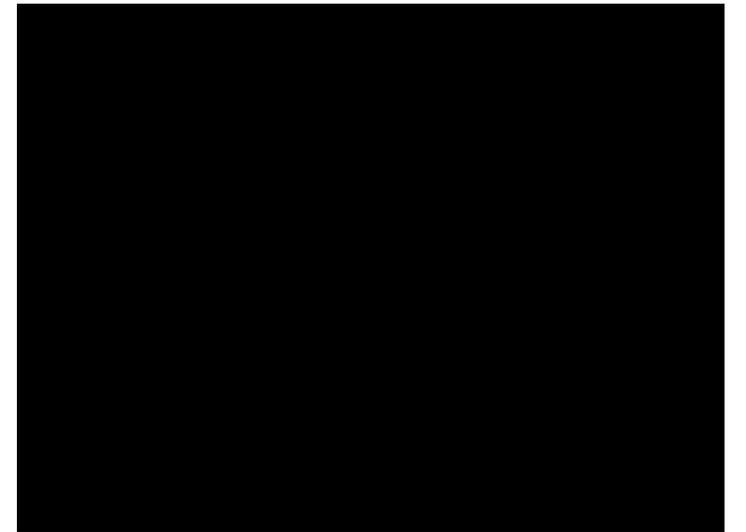
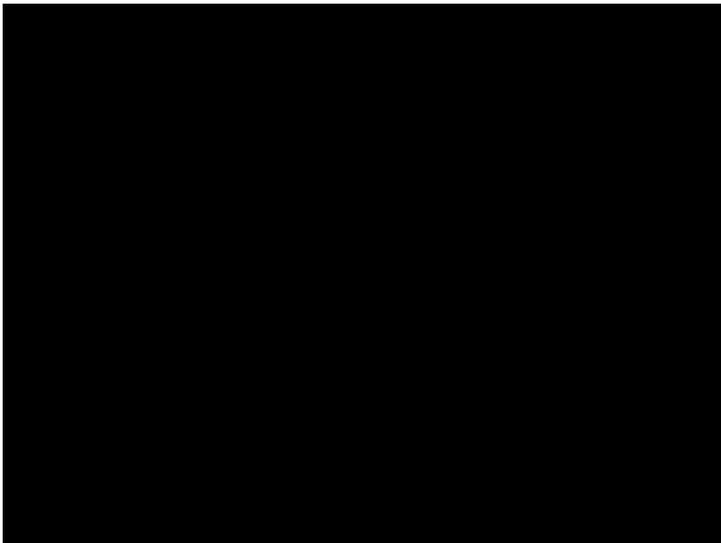
- The subject will step off an 39.6cm high box jump onto a force plate (the force plate is built into the floor and level with floor so it won't cause injury) and the subjects were then instructed to perform a maximal vertical jump landing back on the force plate

<http://www.youtube.com/watch?v=iYG2ziSAOT0>

The Skills

Lateral Cutting

- 3 meter linear run up (marked by a tape lane on the floor) to allow for acceleration prior to cutting maneuver
- The subject will perform a 45° lateral cutting maneuver on a force plate with the dominant leg landing on the force plate
- The subject will have ~3m after the cutting maneuver to decelerate



Systems and Equipment

Surface electrode placement was determined using SENIAM's recommendations (slightly modified to allow for the placement of the functional knee brace (FKB))

Electrodes were placed on 5 muscles that were split into two groups:

- Quadriceps
 - Vastus Medialis (VM)
 - Vastus Lateralis (VL)
 - Rectus Femoris (RF)
- Hamstrings
 - Biceps Femoris (BF)
 - Semitendinosus (ST)

Maximum ground reaction force (GRF) was measured using a standard force plate (AMTI 40x60cm)

Statistics

Muscular activity for data analysis was attained using the root mean square (RMS)

The data was normalized defining the no brace condition as 100% reference value

Brace condition and GRF values are reported as a percentage change to the no brace condition

One sample t-test was used to compare GRF and EMG RMS values for the quadriceps and the hamstrings

A Bonferroni adjustment was used for multiple t-tests

Significance level was set at $p < .01$

Results

N=8

- Age= 20 ± 2.1
- Height (cm)= 195.5 ± 5
- Weight (kg)= 118.2 ± 11.9

EMG and GRF data was analyzed for all 8 subjects, however EMG RMS for the lateral cut for one subject was omitted due to an error in EMG recording

Results contd.

Mean and standard deviation for the normalized condition (GRF was normalized to body mass and EMG RMS for the braced condition was normalized to the no-brace EMG RMS condition) are presented in Table 1.

Table 1. Means and standard deviations for the normalized EMG RMS and GRF data

	Mean	SD
3pt GRF	0.91	0.09
3pt Quad	1.01	0.14
3pt Hams	1.32	0.74
Cut GRF	1.00	0.15
Cut Quad	1.40	0.85
Cut Hams	1.16	0.32
Jump GRF	1.08	0.22
Jump Quad	0.94	0.16
Jump Hams	1.43	0.31

Results

VERTICAL GRF

No significant difference was found in the total vertical GRF between the brace or no brace condition for any of the skills

QUADRICEPS RMS EMG

No significant difference was found in quadriceps RMS EMG between the brace or no brace condition for any of the skills

HAMSTRING RMS EMG

A statistically significant difference was found in the hamstring group during the drop jump ($p=.006$), but no significant difference was found in the lateral cut or 3 point stance (Figure 1)

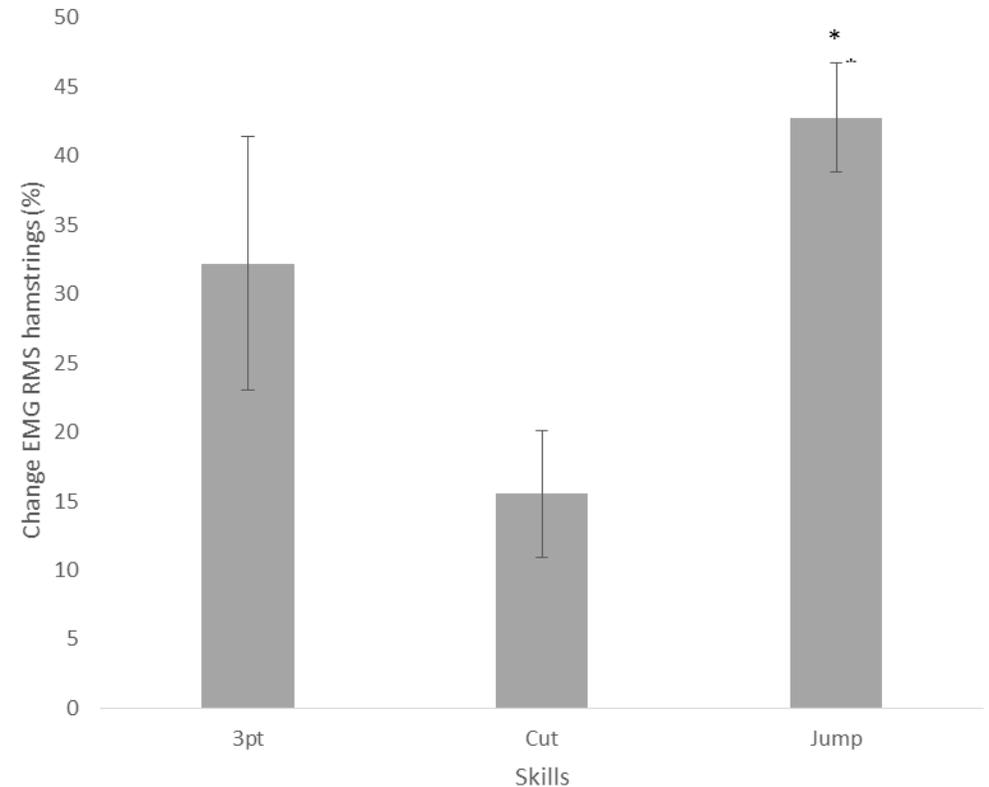


Figure 1. Changes in EMG RMS (mean \pm SE) in the hamstring muscle group. The asterisk denotes significant difference in the EMG RMS ($p=.006$)

Discussion

Results of this study indicate that using a FKB does not have a major impact on movement biomechanics during any of the tested skills

The GRF for the 3 point stance was reduced ($p=.026$) but the power for this component was 1 and therefore an increased sample size could reveal significant differences

A significant increase in RMS was found in the hamstring group during the drop jump

Increased hamstring activity is associated with reduced tibiofemoral shear forces and reduced ACL tension (Biscarini et al 2013)

Increased hamstring activation and decreased quadriceps activation has been found to provide more knee stabilization than a brace (Theoret et al 2006)

Discussion

Increased quadriceps activity and decreased hamstring activity has also been found to increase stability in the knee (in ACL deficient subjects during one legged jumps while wearing a brace) (Ramsey et al 2003)

Hamstring activity has been thought to be inversely related to knee stability (higher hamstring activity, higher joint instability) (Ramsey et al 2003)

Changes in muscular activity have also been thought to be due to changes in proprioceptive feedback (Palm et al 2012)

Muscle activity also depends on movement kinematics (like knee and hip flexion) (Rishiraj et al 2009, Bridge et al 2008)

- Universal complaint from brace wearers is a noticeable lack of range of motion
- This study did not examine joint angles, but this could be the source of increased hamstring activity

Conclusion

Practical applications:

- Research is inconsistent with knee brace effectiveness
- This suggests that effects of brace use is highly individualized
- Implementation of a brace should be prescribed with caution
- Proper strength training and familiarization period for each athlete could help reduce risk of injury caused by increased muscular activity and decreased range of motion
- Knee stabilization can be attained by strengthening surrounding musculature
- Only consistent data produced about utilizing knee braces is the psychological effect

Future studies

- Increase sample size
- Utilize more than one type of brace
- Include kinematic data

Take home message:

- Knee brace implementation should be highly individualized and not blindly enforced for entire teams
- If knee bracing is deemed necessary, proper training should be required in an attempt to reduce muscular and biomechanical effects and maintain normative joint motion

References

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