

## Research Article

# Comparing First-Day Season Tensiomyography Values about Two National League Champions. Differences between Soccer and Futsal

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## Abstract

**Purpose:** To compare contractile properties of quadriceps and biceps femoris muscles in first pre-season training day of futsal/football professional players using tensiomyography to improve muscular status between different football modalities and to assess prevention training.

**Methods:** Two professional men football teams were compared. Tensiomyography (TMG) was performed at first pre-season training week in August 2017 in all healthy patients with no lesions. Neuromuscular values (Contraction time (Tc) and muscle Displacement (Dm)) for VM (Vastus Medialis), VL (Vastus Lateralis), RF (Rectus Femoris) and BF (Biceps Femoris) were compared between left and right leg individually and also comparing both groups.

**Results:** The study showed differences in muscle Contraction Time (Tc) and muscle fibres Deformity (Dm) in biceps femoris comparing F-11 and futsal players being contraction faster and higher stiffness in the first group. Only comparing Dm in rectus femoris had showed differences between both groups. There are no differences between futsal and F-11 professional players in the rest of muscles studied.

**Conclusion:** There are significative differences referring TMG comparison between futsal and F-11 players regarding Contraction Time (Tc) in biceps femoris and muscle Displacement (Dm) comparing biceps femoris, rectus femoris and vastus lateralis in the first day of the season. In-season training programs should be modified among different muscles status and football modalities.

**Keywords:** Tensiomyography; Biceps Femoris; Muscle; Soccer; Football Player; Futsal

## Abbreviations

TMG: Tensiomyography; Tc: Contraction Time; Dm: Muscle Displacement; VM: Vastus Medialis; VL: Vastus Lateralis; BF: Biceps Femoris; RF: Rectus Femoris; F-11: Soccer with 11 players; BMI: Body Mass Index; IRB (Institutional Review Board)

## Introduction

In our society, football practice represents a high volume of social activity being most common sport played [23]. In addition, football is a high demand sport with high risk of lesions where prevention and diagnostic evaluation are essential [21].

In recent years, monitoring study and seasonal controls of player physical status had been performed with different hardware. One of them was Tensiomyography (TMG). TMG is a non-invasive technique developed to assess skeletal muscle mechanical and contractile properties in response to electrical stimuli [21].

TMG reveals information about muscle stiffness (or tone), contraction speed, predominant skeletal muscle fibers and also muscle fatigue [14-15,19,21,27]. It has been employed to assess the

neuromuscular characteristics of skeletal muscles in a variety of populations and diseases: young healthy subjects [3,4,8,13,18,25-26], peripheral artery disease [11], diabetic polyneuropathy [22], paralytic poliomyelitis [12], multiple sclerosis [17], and athletes [5,9].

The neuromuscular characteristics of soccer players have already been evaluated using TMG. Specially, studies have used TMG to assess the effects of cold water exposure [10], recovery interventions (after training sessions) [20], playing position [19], anterior cruciate ligament reconstruction [1], and different types of training [21] on mechanical and contractile properties of skeletal muscles of the lower extremity.

As we known, there was no studies comparing contractile properties of muscles in two different modalities of football (futsal and outdoor).

The aim of this study is to study contractile properties of quadriceps and biceps femoris muscles in first pre-season training day of futsal and football professional players. Study hypothesis is that there are no differences between the different modalities of football.

## Material and Methods

Two professional men football player teams (Tegner 10) were compared. First group (group A) included 14 members of futsal team, whom were playing national and international championships. Group B including 14 players from a national league Football (F-11) team playing at same level than futsal team.

Usually the components of futsal team were 14 players and that was the reason to included 14 players in each group. In F-11 players we included similar position players to compare both groups avoiding bias. Data collection including age, BMI (Body Mass Index), field position and dominance were comparing obtaining no differences between groups (Tables 1 & 2).

Tensiomyography (TMG) was performed at first pre-season training week in August 2017 (Season 2017-2018). All evaluated patients showed no active lesions at the moment of the TMG during first days of return to season workout.

All patients included in the present study were informed and sign consent to perform TMG test [6]. Instructions for the test perform were: rest without high level exercise 48 hours previously, avoid energetic drinks or supplements in 48 hours previously, avoid alcohol and caffeine 3 hours before and no food ingest 2 hours before the test respectively. Neuromuscular values for VM (Vastus Medialis), VL (Vastus Lateralis), RF (Rectus Femoris) and BF (Biceps Femoris) were compared between left and right leg individually and also comparing both groups.

### TMG specifications

TMG was used to assess the mechanical properties of VL, VM, RF and BF in both legs. Measurements were taken under static and relaxed conditions. Prior to performing the measurements, an accurate digital displacement-transducer (GK 40, Panoptik doo, Ljubljana, Slovenia) was perpendicularly positioned at the highest point of the muscle belly following indications suggested by Perotto et al [24]. Recent systematic review had confirmed that all TMG parameters (except half-relaxation time) have high relative reliability scores while low measurement error, especially Dm and Tc [16]. To assure the same placement of electrodes between the consecutive measurements, this point was marked with a skin permanent marker. To cause the twitch responses, quadrangular adhesive electrodes (5x5cm) (TheraTrode<sup>®</sup>, TheraSigma, California, United States of America) were connected to an electric stimulator (TMG-S1 doo, Ljubljana, Slovenia) and positioned on the muscle surface, following the arrangement of the fibres. The electrodes were placed symmetrically approximately 5 cm away from the sensor, placing the positive electrode in the proximal area of the muscle above the measurement point and the negative electrode in the distal area below the measurement point, according to previous investigations [7]. The electrical stimulation was applied with a pulse duration of 1 ms and an initial current amplitude of 30 mA, which was progressively increased in 10 mA steps, until maximal output stimulator (110mA). A 15-s rest period was allowed between each electrical stimulus to avoid fatigue or post-tetanic activation [15]. The same experienced evaluator executed all measurements and only the curve with the highest Dm value was considered for further analysis.

Each measurement involved recording the following parameters:

maximum radial muscle displacement (Dm, in mm) and contraction time (Tc, in ms) from 10% to 90% of Dm.

IRB approval was given by our institution.

### Statistical analysis

Descriptive statistics were used to summarize all demographic characteristics as well as outcomes. A Shapiro-Wilk test was first conducted to assess for normal distribution of all the evaluated parameters. For variables with normal distribution, an unpaired Student's t test was employed to compare the TMG values between both sides. For variables not following a normal distribution, a Mann-Whitney test was used for the comparison of TMG values between sides. A separate sample size calculation was conducted for the Tc and Dm parameters, and involved all muscle groups of a preliminary sample of 20 patients. The minimum sample size that was considered for the whole study was obtained from the comparison that elicited the highest value of sample size. The Tc corresponded to the result of calculating the highest number of patients needed for the study to compare the TMG values between both lower extremities. All statistical analyses were conducted using the SPSS v.21 (SPSS, Inc. Chicago, IL, USA). The alpha level was set up at 0.05.

## Results

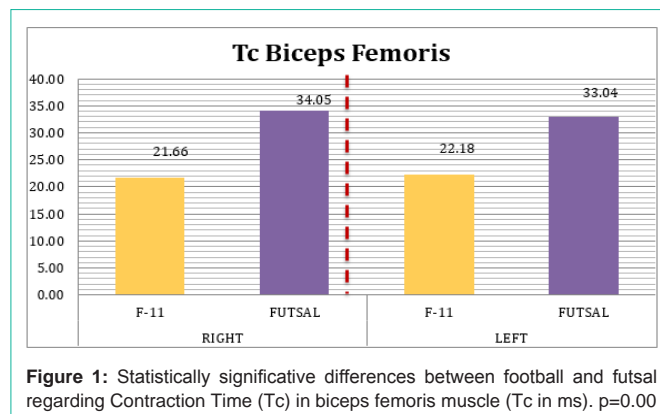
Present study showed differences in muscle Contraction Time (Tc) such as muscle fibers Deformity (Dm) in some of the studied muscles:

In contraction time of biceps femoris were observed differences between f-11 players and futsal players being first ones faster ( $p=0.00$ ) (Figure 1 and Table 3).

Evaluating the results of comparing the left vastus lateralis, we also obtained significant differences between both groups ( $p=0.01$ ) (Figure 2), being Tc results faster in futsal players group.

Comparing rectus femoris and vastus medialis there is no differences between both groups in terms of Tc results (n.s.)

Despite of muscle fibers stiffness evaluation, futsal group has showed less stiffness in biceps femoris ( $p=0.00$ ) (Figure 3), rectus femoris ( $p=0.00$ ) in left-side leg and  $p=0.03$  in the right side) (Figure 4) and vastus lateralis (in this group differences were obtained only in right side ( $p=0.03$ ) with p-value (n.s.) non significant in left side) than F-11 group (Figure 5). There are no significant differences between groups in vastus medialis Dm score.



**Figure 1:** Statistically significant differences between football and futsal regarding Contraction Time (Tc) in biceps femoris muscle (Tc in ms).  $p=0.00$

**Table 1:** No differences were observed comparing leg dominance.

	F-11	Futsal	Statistical test	P VALUE
Right-handed	10	12	Chi-Square (Continuity correction)	0,645
Left-handed	4	2		
TOTAL	14	14		

**Table 2:** No differences were observed comparing age and body Mass Index (BMI) between both groups.

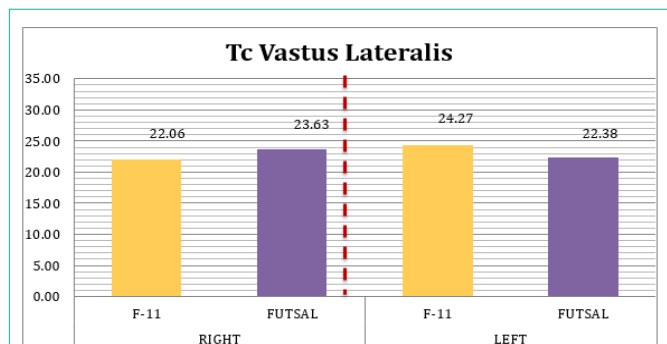
	mean	SD	S-W	mean	SD	S-W		
AGE	25,21	4,41	0,185	27,64	2,13	0,185	U de Mann-Whitney	0,079
BMI	23,56	1,68	0,092	24,18	1,19	0,783	T-Student	0,270

**Table 3:** Muscle Contraction Time (Tc) of all evaluated muscles showing differences between laterality and football modality. S-W=Shapiro West test.

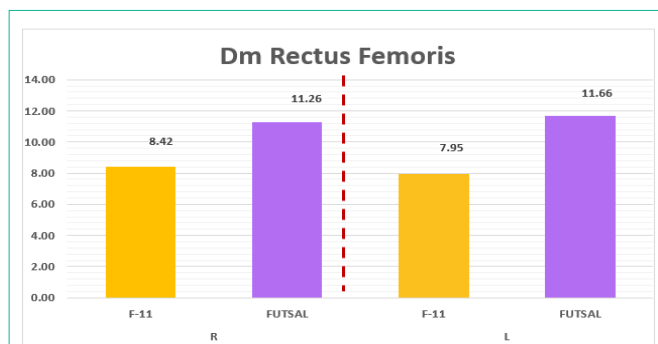
		MODALITY	Mean	SD	S-W	TEST	P-value
Dm Biceps Femoris	R	F-11	4,31	1,25	0,090	T-Student	0,000
		FUTSAL	9,47	2,59	0,851		
	L	F-11	3,98	1,04	0,062	T-Student	0,000
		FUTSAL	10,69	2,34	0,413		
Dm Rectus Femoris	R	F-11	8,42	3,27	0,250	T-Student	0,032
		FUTSAL	11,26	3,33	0,307		
	L	F-11	7,95	2,19	0,963	T-Student	0,000
		FUTSAL	11,66	2,43	0,055		
Dm Vastus Lateralis	R	F-11	5,94	1,60	0,141	T-Student	0,034
		FUTSAL	7,39	1,84	0,324		
	L	F-11	6,01	1,76	0,654	U de Mann-Whitney	0,056
		FUTSAL	7,84	2,67	0,008		
Dm Vastus Medialis	R	F-11	8,01	1,50	0,804	T-Student	0,770
		FUTSAL	8,21	2,10	0,074		
	L	F-11	8,68	1,96	0,072	T-Student	0,108
		FUTSAL	9,72	1,28	0,255		

**Table 4:** Stiffness degree (Dm) of evaluated muscles regarding side and football modality. S-W=Shapiro West test.

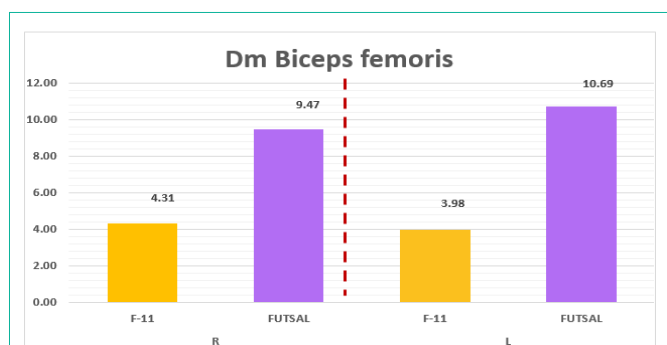
		MODALITY	Mean	SD	S-W	TEST	P-value
Dm Biceps Femoris	R	F-11	4,31	1,25	0,090	T-Student	0,000
		FUTSAL	9,47	2,59	0,851		
	L	F-11	3,98	1,04	0,062	T-Student	0,000
		FUTSAL	10,69	2,34	0,413		
Dm Rectus Femoris	R	F-11	8,42	3,27	0,250	T-Student	0,032
		FUTSAL	11,26	3,33	0,307		
	L	F-11	7,95	2,19	0,963	T-Student	0,000
		FUTSAL	11,66	2,43	0,055		
Dm Vastus Lateralis	R	F-11	5,94	1,60	0,141	T-Student	0,034
		FUTSAL	7,39	1,84	0,324		
	L	F-11	6,01	1,76	0,654	U de Mann-Whitney	0,056
		FUTSAL	7,84	2,67	0,008		
Dm Vastus Medialis	R	F-11	8,01	1,50	0,804	T-Student	0,770
		FUTSAL	8,21	2,10	0,074		
	L	F-11	8,68	1,96	0,072	T-Student	0,108
		FUTSAL	9,72	1,28	0,255		



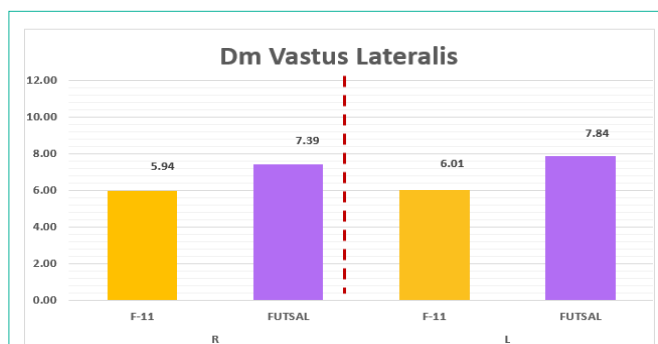
**Figure 2:** Significant differences between left and right side evaluating contraction time in vastus lateralis muscle. (Tc in ms) (p=0.01).



**Figure 4:** Statistically differences obtained comparing both groups (p=0.00) showing less stiffness evaluating rectus femoris in futsal players than F-11 players. (Dm in mm)



**Figure 3:** Statistically differences obtained comparing both groups (p=0.00) showing less stiffness evaluating biceps femoris in futsal players than F-11 players. (Dm in mm)



**Figure 5:** Statistically differences obtained comparing both groups (p=0.00). Futsal players show higher Dm score in vastus lateralis score. (Dm in mm)

## Discussion

The most important finding of the present study was significant differences obtained between futsal and F-11 in Contraction Time (Tc) and muscle displacement (stiffness) parameters in TMG results.

Regarding the moment of the season analysed, García-García [6] et al showed similar results of TMG in first season day in an equivalent population of F-11 players. However their results were worse than our results in F-11, but quite similar to our futsal results. Mean values of Garcia-Garcia study were 25, 26, 30 and 34 ms in Tc results of VM, VL, RF and BF respectively, while F-11 values in our group were 23, 23, 27 y 21 respectively and futsal results were 22, 23, 28 y 33, quite similar to published from Garcia-Garcia [6].

In our study, we have seen differences between Tc results in biceps femoris however, the other measurements did not show significant differences comparing both groups (with exception of left side vastus lateralis Tc measure where higher contraction speed (Tc) was observed in F-11 group (Tables 5-6).

Football players had slower Tc and higher Dm in first day of the season than others athletes such as cyclists because of the specific training program that both sports perform [5,6].

Previous studies showed faster Tc parameters in sprinters than normal non-trained population (19 versus 30) [2].

Minor stiff muscle fibers (Dm) of biceps femoris and rectus femoris had been obtained in futsal group. According to the results

**Table 5:** Mean values of Tc in both groups of the study comparing with García García et al. [26] (F-11 group. Significant differences were showed in bold type.

Tc	VM	VL	RF	BF
F-11	23.22	23.16	27.74	21.92
Futsal	22.23	23	28.56	33.54
García	25	26.1	30.9	34.5

**Table 6:** Mean values of Dm in both groups of the study comparing with García García et al. [26] (gF-11 group. Significant differences were showed in bold type.

Dm	VM	VL	RF	BF
F-11	8.34	5.97	8.18	4.14
Futsal	8.97	7.61	11.46	10.08
García (F11)	9.1	7.2	10.4	7

of vastus lateralis differences were obtained but only in the results of right side, not in the left side, however, p-value is near significance limit and sample is only of 14 patients so which situation would had limitations of these results. Nevertheless, obtained results showed the tendency to less stiffness (high value of Dm results) in futsal players muscles, than could be compared with higher elasticity capacity and faster movements during sport practice in futsal players than F-11 players.

Comparing our results with Garcia et al work, we found Dm values of 9.1, 7.2, 10.4 and 7 en VM, VL, RF y BF respectively, while the results of our work were 8.3, 5.9, 8.1 and 4.1 in F-11 and 8.9, 7.6, 11.4 and 10 respectively in futsal. RF and BF values showed significant

differences comparing F-11, futsal and Garcia group (Table 6) Differences between the results in our F-11 group and Garcia group should be explained because of the different program training in the football team.

Higher power training or specific stretching programs would contribute to these differences between players.

On the other hand, faster results in biceps femoris muscle contraction had seen in F-11 groups can also be explained for the kind of practice comparing to futsal. These results showed us than the different kind of football discipline should develop different structural muscle work. Futsal players have less stiffness of their muscle fibers while F-11 players show higher stiffness but faster response to contraction in muscles such as biceps femoris.

The findings of this work are the first step to perform better training and sport-specific programs for professional and non-professional teams.

There is no differences between both group referring dominance as previous studies showed, not only in professional football players [6], also in amateur football players [1,15] or cyclists [5].

Garcia et al [6] compared their values with the field position of their group, obtaining differences between the position and the TMG results, however, we did not perform this analysis because of the sample size, which we consider is one of the most important limitations of the study.

## Limitations

As we explained previously, the most important limitation of our study was the sample size. However, the sample belongs to professional football and futsal and the differences obtained with this small sample and the tendency observed reinforce our conclusions.

Another limitation of the study was inherent to TMG. Only superficial muscles can be evaluated by TMG and there is no way to evaluate the functionality of bigger or complete groups. Anyway, previous works allow us to validate our results and let us to perform new studies design.

The present study was designed to evaluate first day of the season muscle status. Despite of the holiday previous period, some players continue with their training plan between seasons.

Interseason training program is difficult to control and should be a correction factor, such as during season comparative results would be different depending match play, training programs, GPS results and injuries. Analyzing first day season could limit the study to take conclusions of a short period of time and could be no representative of the muscular status between groups such as showed in Garcia et al work [6].

## Conclusion

In conclusion, there are significant differences between TMG comparison between futsal and F-11 players regarding Contraction Time (Tc) in biceps femoris and muscle displacement (Stiffness-Dm) comparing biceps femoris, rectus femoris and vastus lateralis in the first day of the season.

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