운동상해 예방을 위한 Tensiomyography 활용방안 탐색

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1. Introduction

1. Introduction

스포츠과학 : 다양한 분야에서 이루어지고 있음

- 운동선수의 근기능(muscle function)
  - 운동선수의 경기력을 결정하는 중요한 요인으로 작용
  - 선수 발굴, 훈련 강도 및 프로그램 구성, 상해 예방을 위한 근거로 활용(Kim, 2013)
- 근기능 평가를 위한 도구(tool)
  - isokinetic dynamometer
  - surface electromyogram(sEMG)
  - mechanomyogram(MMG)
  - myotonometer

1. Introduction

Tensiomyography(TMG) – 근기능 평가를 위한 새로운 도구

- Slovenia Ljubljana 대학 전자공학과 재활연구소 개발 (Valenčič, & Knez, 1997)
- 비침습적(noninvasive)인 근신경학적 평가 방법
- 단일 전기자극을 통해 muscle contraction시
  - muscle belly의 displacement 측정
  - muscle contractile properties 평가
- 장점(Tous-Fajard et al., 2010)
  - 측정하고자 하는 근육을 선택적으로 검사
  - 측정이 비교적 간단 & 이동이 쉬워 현장 활용도 높음
- 유럽을 중심으로 스포츠의학 & 선수트레이닝 분야에 널리 사용

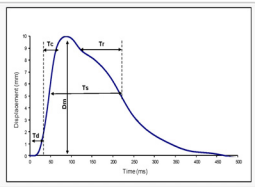
2. Tensiomyography System

TMG system components

- ① Electrical stimulator & Software program
- ② Digital sensor ④ Electrode
- ③ Tripod & Manipulating hand

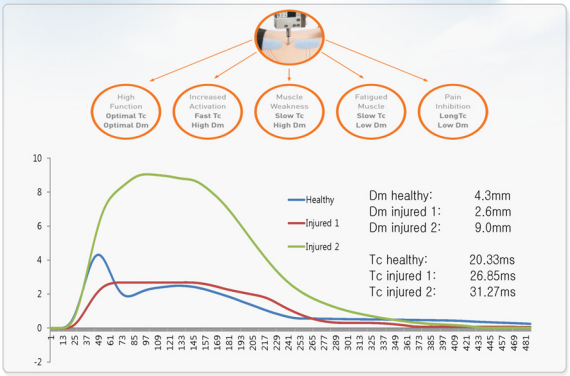
TMG record with parameters graph

- Tc : contraction time
- Tr : relaxation time
- Ts : sustain time
- Dm : maximal displacement
- Td : delay time



2. Tensiomyography System

Muscle response scenarios



2. Tensiomyography System

Data analysis (1)

- Basic results
- Lateral & functional symmetry

Good Adequate Slow Too Loose Too Stiff

Lateral Symmetry (LS):

Muscle	Side	Tc [ms]	Ts [ms]	Tr [ms]	Dm [mm]	Td [ms]	Sim [%]
m.BF	R	21.89	214.54	47.34	4.07	28.17	
m.BF	L	34.82	175.10	24.76	2.51	24.80	67

Functional Symmetry (FS):

Elbow: (BB/TB) R / L — Sim [%]

Knee: (VL&VM&RF/BF) R / L — Sim [%] 85

LATERAL SYMMETRY (LS):

BF Biceps Femoris

General Biceps Femoris (BF) muscle LS is significantly lower than recommended 67%.
LS of contraction time is significantly lower than recommended. Slower is the muscle on the left side.
LS of maximal displacement is significantly lower than recommended. It is lower on the left side.
The muscle is slightly slower than selected sport average.
We recommend activation exercises for left side and strength exercises for both sides.

FUNCTIONAL SYMMETRY (FS):

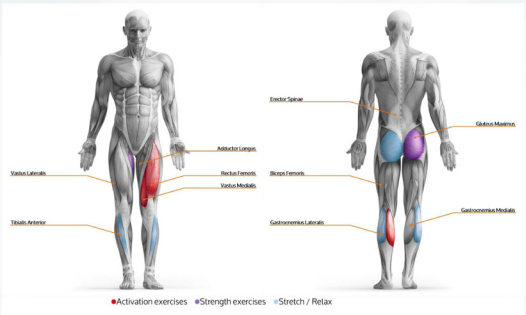
L Knee

General FS of the left Knee is significantly lower than recommended 70%.
FS of contraction time is significantly lower than recommended. Knee flexor muscle (BF) is the slower one. We recommend activation exercises.

2. Tensiomyography System

Data analysis (2)

- Comments / Recommendations



3. Tensiomyography Application Areas

TMG information

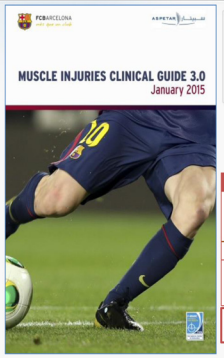
- Muscle stiffness or tone
- Muscle fatigue
- Muscle contraction velocity
- Type of predominant skeletal muscle fibers

- Sports Field : Performance, Injury prevention, Rehabilitation monitoring

- Research Category(Chai et al., 2017)
  - Disease(Multiple sclerosis patients et al.)
  - Ligament injury
  - Muscle fatigue or injury
  - Physiological study

4. Used example in Sports field

FC Barcelona



"Tensiomyography is used for follow-up the functional recovery of muscle and to help decide return to play"

FC Barcelona & ASPETAR Example :
"Management of a muscle injury"

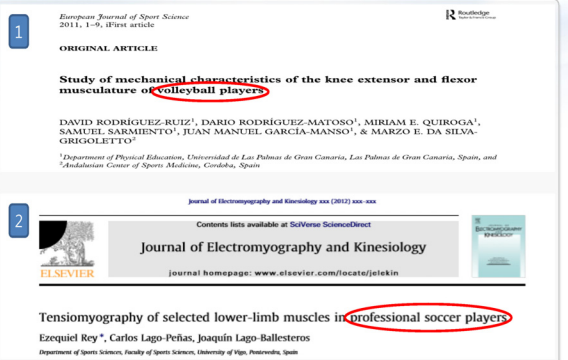
		Clinical history	Physical exam	US	MRI	Treatment
	Immediate	X	X			Rest Ice Compression Elevation Analgesia
	12 hours		X	X	Could be made anytime	
	24 hours		X	X		
	48 hours		X	X		
					Functional tests	
	1st week	Monitorize players feelings	X	x	To evaluate how the progression of loads are assumed	Rehabilitation progressive protocol
	Weekly		X	X		
	Return to play		X	X		

For follow-up the functional recovery and sometimes to help to decide return to play:
- *Muscle:* **Tensiomyography**, electromyography and strength tests.
- *Player:* GPS, HR and self administered scales during and after the rehabilitation sessions on field.

5. Advanced Research using Tensiomyography

Physiological study(1)

1



European Journal of Sport Science
2011, 1–9, iFirst article

ORIGINAL ARTICLE

Study of mechanical characteristics of the knee extensor and flexor musculature of volleyball players

DAVID RODRÍGUEZ-RUIZ[1], DARIO RODRÍGUEZ-MATOSO[1], MIRIAM E. QUIROGA[1], SAMUEL SARMIENTO[1], JUAN MANUEL GARCÍA-MANSO[1], & MARZO E. DA SILVA-GRIGOLETTO[2]

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2

Journal of Electromyography and Kinesiology xxx (2012) xxx–xxx

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Journal of Electromyography and Kinesiology

journal homepage: www.elsevier.com/locate/jelekin

Tensiomyography of selected lower-limb muscles in professional soccer players

Ezequiel Rey *, Carlos Lago-Peñas, Joaquín Lago-Ballesteros

Department of Sports Sciences, Faculty of Sports Sciences, University of Vigo, Pontevedra, Spain

5. Advanced Research using Tensiomyography

Physiological study(2)

3 THE TENSIOMYOGRAPHY USED FOR EVALUATING HIGH LEVEL BEACH VOLLEYBALL PLAYERS

LOCOMOTOR APPARATUS IN EXERCISE AND SPORTS

ORIGINAL ARTICLE

David Rodríguez Ruiz[1]
Miriam Esther Quiroga Escudero[1]
Darío Rodríguez Matoso[1]
Samuel Sarmiento Montesdeoca[1]
José Losa Reyna[2]
Yves de Saá Guerra[1]
Gloria Perdomo Bautista[1]
Juan Manuel García Manso[1]

ABSTRACT

Objective: The aim of this investigation is to obtain information about muscle stiffness, the mechanic and contractile properties of the muscles using the TMG with high level beach volleyball players as well as to demonstrate the usefulness of this method to evaluate the muscles in charge of the knee flexion and extension. Methods: The investigation was carried out with a group of 24 beach volleyball players who took part in the Nestea European Championship Tour - Spanish Master held in the Gran Canaria, May 2009. The method of study used was a comparison of the individual cases of various athletes to

4 Journal of Electromyography and Kinesiology 30 (2016) 73–80

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journal homepage: www.elsevier.com/locate/jelekin

ELSEVIER

Muscle mechanical properties of strength and endurance athletes and changes after one week of intensive training

CrossMark

Rauno Álvaro de Paula Simola[a,*], Christian Raeder[a], Thimo Wiewelhove[a], Michael Kellmann[b,c], Tim Meyer[d], Mark Pfeiffer[e], Alexander Ferrauti[a]

5. Advanced Research using Tensiomyography

Physiological study(3)

5 SciMedCentral — Annals of Sports Medicine and Research

Research Article

Preseason Neuromuscular Profile of Knee Extensor and Flexor Muscles in Elite Amateur Road Cyclist's Assessment through Tensiomyography

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Keywords
• Season
• Cycling
• Muscle contraction
• Symmetry
• Asymmetry

6 Knee Surg Sports Traumatol Arthrosc (2016) 24:2259–2263
DOI 10.1007/s00167-014-3298-5

CrossMark

SPORTS MEDICINE

Comparison of tensiomyographic neuromuscular characteristics between muscles of the dominant and non-dominant lower extremity in male soccer players

Pedro Alvarez-Diaz · Eduard Alentorn-Geli · Silvia Ramon · Miguel Marin · Gilbert Steinbacher · Marta Rius · Roberto Seijas · Jordi Ballester · Ramon Cugat

5. Advanced Research using Tensiomyography

Physiological study(4)

7 Journal of Human Kinetics volume 58/2017, 23-34 DOI: 10.1515/hukin-2017-0066 23
Section I – Kinesiology

DE GRUYTER OPEN

Baseline Mechanical and Neuromuscular Profile of Knee Extensor and Flexor Muscles in Professional Soccer Players at the Start of the Pre-Season

by
Oscar García-García[1], Virginia Serrano-Gómez[2], Antonio Hernández-Mendo[2], Verónica Morales-Sánchez[2]

Soccer, Volleyball, Beach volleyball, Strength & Endurance athlete
Road cyclist의 lower muscle contraction 파악

운동상해 예방 및 경기력 향상을 위한 프로그램 마련

5. Advanced Research using Tensiomyography

Ligament injury(1)

1 Knee Surg Sports Traumatol Arthrosc (2015) 23:2502–2507
DOI 10.1007/s00167-014-3007-4

CrossMark

SPORTS MEDICINE

Assessment of gastrocnemius tensiomyographic neuromuscular characteristics as risk factors for anterior cruciate ligament injury in male soccer players

Eduard Alentorn-Geli · Pedro Alvarez-Diaz · Silvia Ramon · Miguel Marin · Gilbert Steinbacher · Marta Rius · Roberto Seijas · Oscar Ares · Ramon Cugat

2 Knee Surg Sports Traumatol Arthrosc (2016) 24:2264–2270
DOI 10.1007/s00167-014-3319-4

CrossMark

SPORTS MEDICINE

Effects of anterior cruciate ligament injury on neuromuscular tensiomyographic characteristics of the lower extremity in competitive male soccer players

Pedro Alvarez-Diaz · Eduard Alentorn-Geli · Silvia Ramon · Miguel Marin · Gilbert Steinbacher · Juan José Boffa · Xavier Cuscó · Oscar Ares · Jordi Ballester · Ramon Cugat

5. Advanced Research using Tensiomyography

Ligament injury(2)

3 Knee Surg Sports Traumatol Arthrosc
DOI 10.1007/s00167-017-4460-7

CrossMark

KNEE

Symmetry tensiomyographic neuromuscular response after chronic anterior cruciate ligament (ACL) reconstruction

Noriaki Maeda[1] · Yukio Urabe[1] · Syogo Tsutsumi[1] · Hironori Fujishita[1] · Shuhei Numano[1] · Takuya Takeuchi[1] · Kazuhiko Hirata[2] · Yukio Mikami[3] · Hiroaki Kimura[3]

ACL injury로 인한
lower muscle contractile velocity, fatigue, muscle stiffness 영향 파악

운동선수의 회복을 최적화하기 위한 재활프로그램 계획

5. Advanced Research using Tensiomyography

Muscle fatigue & injury(1)

1 Journal of Sports Sciences, March 15th 2011; 29(6): 619–625

Routledge

Assessment of muscle fatigue after an ultra-endurance triathlon using tensiomyography (TMG)

JUAN MANUEL GARCÍA-MANSO, DAVID RODRÍGUEZ-RUIZ, DARIO RODRÍGUEZ-MATOSO, YVES DE SAA, SAMUEL SARMIENTO, & MIRIAM QUIROGA

Department of Physical Education, Universidad de Las Palmas de Gran Canaria, Las Palmas, Gran Canaria, Spain

2 Journal of Electromyography and Kinesiology xxx (2012) xxx–xxx

Contents lists available at SciVerse ScienceDirect

Journal of Electromyography and Kinesiology

journal homepage: www.elsevier.com/locate/jelekin

ELSEVIER

Assessment of eccentric exercise-induced muscle damage of the elbow flexors by tensiomyography

Angus M Hunter[a,*], Stuart DR Galloway[a], Iain J Smith[a], Jamie Tallent[b], Massimiliano Ditroilo[c], Malcolm M Fairweather[d], Glyn Howatson[b,e]

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[b] Department of Sport and Exercise Sciences, Northumbria University, Newcastle, UK
[c] School of Public Health, Physiotherapy and Population Science, University College Dublin, Ireland
[d] Sportscotland Institute of Sport, Stirling, UK
[e] Centre of Aquatic Research, University of Johannesburg, Gauteng, South Africa

5. Advanced Research using Tensiomyography

Muscle fatigue & injury(2)

3

Journal of Sport Rehabilitation, 2016, 25, 241-247
http://dx.doi.org/10.1123/jsr.2014-0325
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Human Kinetics
ORIGINAL RESEARCH REPORT

Reduced Radial Displacement of the Gastrocnemius Medialis Muscle After Electrically Elicited Fatigue

Lewis J. Macgregor, Massimiliano Ditroilo, Iain J. Smith, Malcolm M. Fairweather, and Angus M. Hunter

Study on muscle function injury & fatigue after inducing muscle damage

과도한 훈련 예방 및 과학적인 선수 관리 방안 마련

5. Advanced Research using Tensiomyography

국내 연구 동향

1

Clinical Article The Korean Journal of Sports Medicine 2016;34(2):146-152
pISSN 1226-3729 eISSN 2288-6028 https://doi.org/10.5763/kjsm.2016.34.2.146

Tensiomyography를 이용한 보디빌더 근육의 특성 분석

윤지대학교 의과대학 생리학교실[1], 고려대학교 사회체육과[2], 순천향대학교 스포츠의학과[3], 글로벌든든병원[4]

채정훈[1]* · 김보경[2]* · 김 찬[1] · 김철현[3] · 배상원[4]

2

한국사회체육학회지, 제69호, pp. 387~394
Journal of Sport and Leisure Studies
2017, Vol. 69, pp. 387~394

Tensiomyography를 이용한 고등학교 농구선수의 무릎관절 신전 및 굴곡 근육의 수축 특성 비교

어 온 실·*황 부 근(우송대학교)

5. Advanced Research using Tensiomyography

국내 연구 동향

3

Clinical Article The Korean Journal of Sports Medicine 2017;35(3):181-189
pISSN 1226-3729 eISSN 2288-6028 https://doi.org/10.5763/kjsm.2017.35.3.181

Tensiomyography를 이용한
남녀 하지 근육의 특성 분석

고려대학교 사회체육과[1], 순천향대학교 스포츠의학과[2], 윤지대학교 의과대학 생리학교실[3], 글로벌든든병원[4]

김보경[1]* · 채정훈[2]* · 김 찬[2] · 김철현[2] · 배상원[4]

4

한국체육학회지, 2018, 제57권 제2호, 599-609
http://dx.doi.org/10.23949/kpe.2018.03.57.2.42

The Korean Journal of Physical Education, 2018, 57(2), 599-609
ISSN 1738-9666(Print) / ISSN 2508-1029(Online)

Tensiomyography를 이용한 대학 남자 축구선수의 하지 근수축 특성 분석

Analysis of Contractile Properties in Lower Extremity Muscles of Collegiate Male Soccer Players Using Tensiomyography

어은실 우송대학교 · 윤진환 한남대학교 · 황부근* 우송대학교

Eo, Eun-Shil *Woosong Univ.* · Yoon Jin-Hwan *Hannam Univ.* · Hwang Boo-Geun* *Woosong Univ.*

6. Conclusion

Sports field : 현장 활용성 검토 필요

- 개개인의 부상 위험을 미리 감지하여 보강운동 등 개인별 맞춤 트레이닝 전략
- 팀별 시즌 전 & 중 & 후 monitoring를 통한 효율적인 선수 관리 및 운영

Research : 다양한 분야에서의 접근성 필요

- 국내 각 종목별 선수들의 근수축 특성에 대한 기준치 개발
  → 개인별 근기능 상태 파악을 통한 상해 예방 선수 관리 프로그램 마련
- 다양한 근기능 평가 장비와의 상호 비교를 통한 운동생리학적 연구
  → 각 근육별 근기능 향상을 위한 트레이닝 프로그램 개발 및 적용
- 다양한 조직 (ligament 등) 손상 후 나타나는 근수축 능력 변화 상태 규명
  → 회복을 최적화 하기 위한 재활프로그램 마련
- muscle stiffness or fatigue를 효과적으로 개선하기 위한 프로그램 개발

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