
بسم الله الرحمن الرحيم


فَأَمَّا الزَّبَدُ فَيَذْهَبُ جُفَاءً وَأَمَّا
مَا يَنفَعُ النَّاسَ فَيَمْكُثُ فِي
الأَرْضِ
سورة الرعد (17)

MECHANICAL RESPONSES TO HIP VERSUS KNEE INDUCED MUSCLE FATIGUE IN PATELLOFEMORAL PAIN SYNDROME

الاستجابات الميكانيكية للاجهاد المستحث لعضلات الفخذ مقابل عضلات الركبة فى متلازمة آلام الرضفة

By

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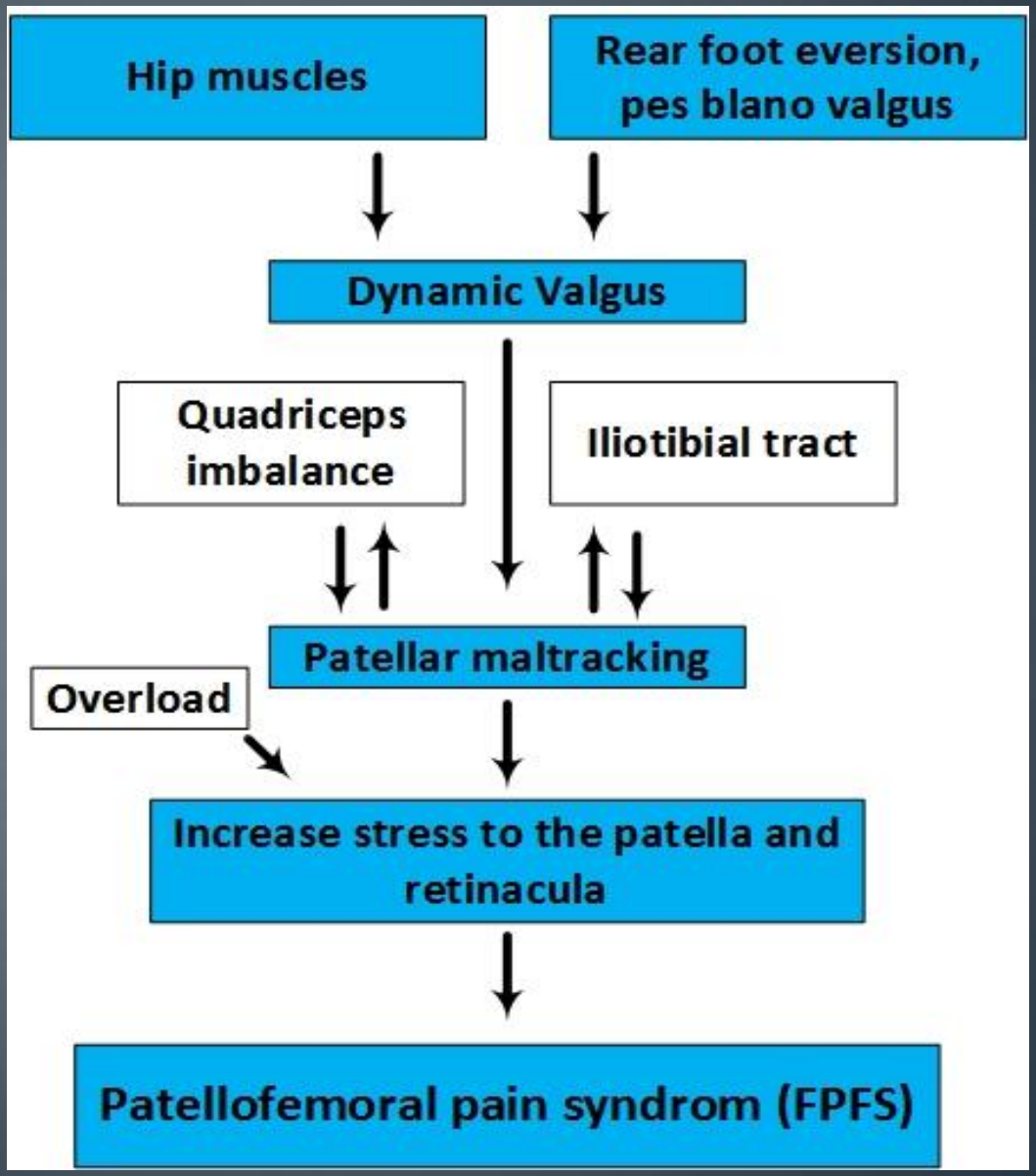
- *My husband and parents*

Introduction

Patellofemoral pain Syndrome (PFPS)

- **Definition:** diffuse anterior or retropatellar knee pain exacerbated by activities such as stair climbing, prolonged sitting, kneeling, running and squatting.
- It is a pathology in which patella is translated or tilted laterally leading to alteration in patellofemoral contact pressure.

Pathomechanics



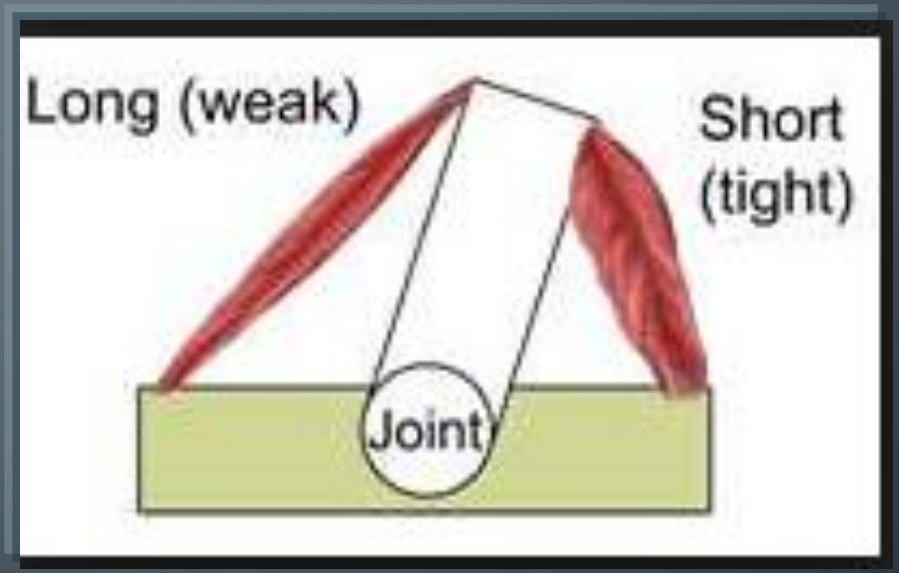
Several risk factors may lead to Patellar mal-alignment

Muscle imbalance resulted from

VMO muscle

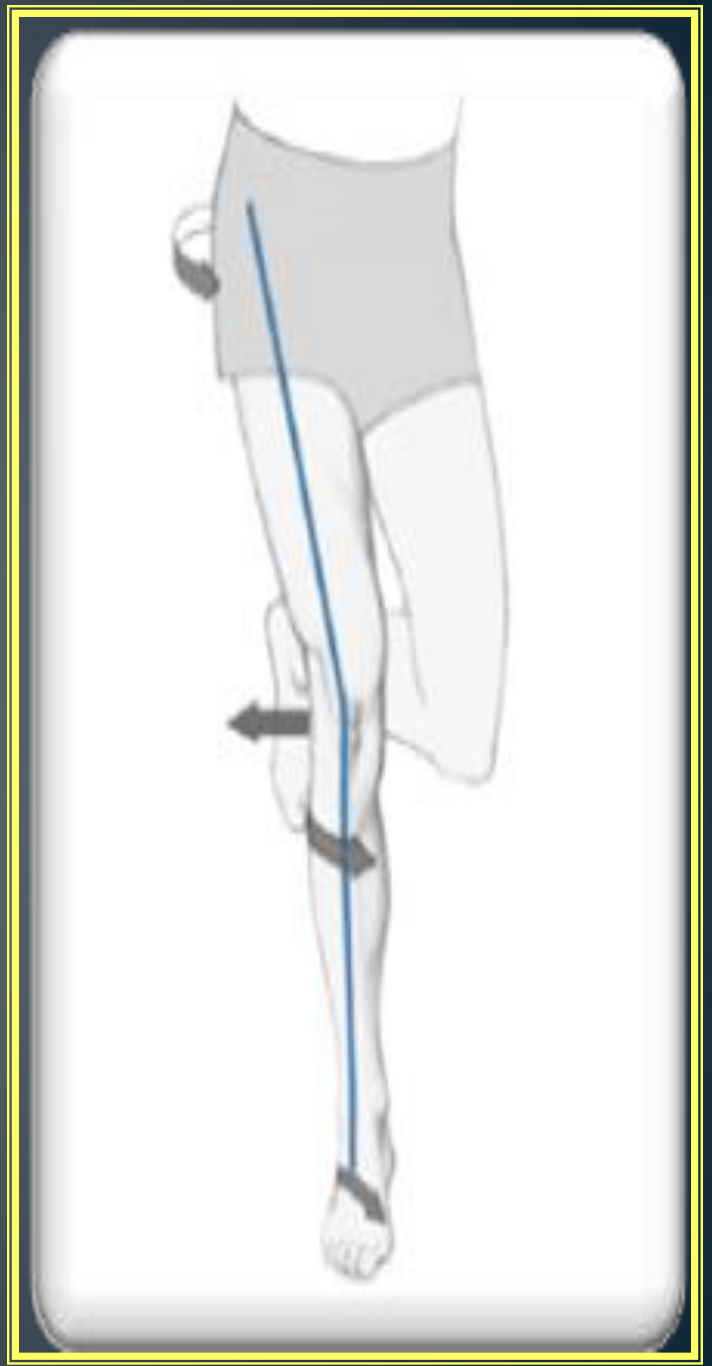
Slow contraction velocity (Type I)

Always is inhibited due to Q angle.

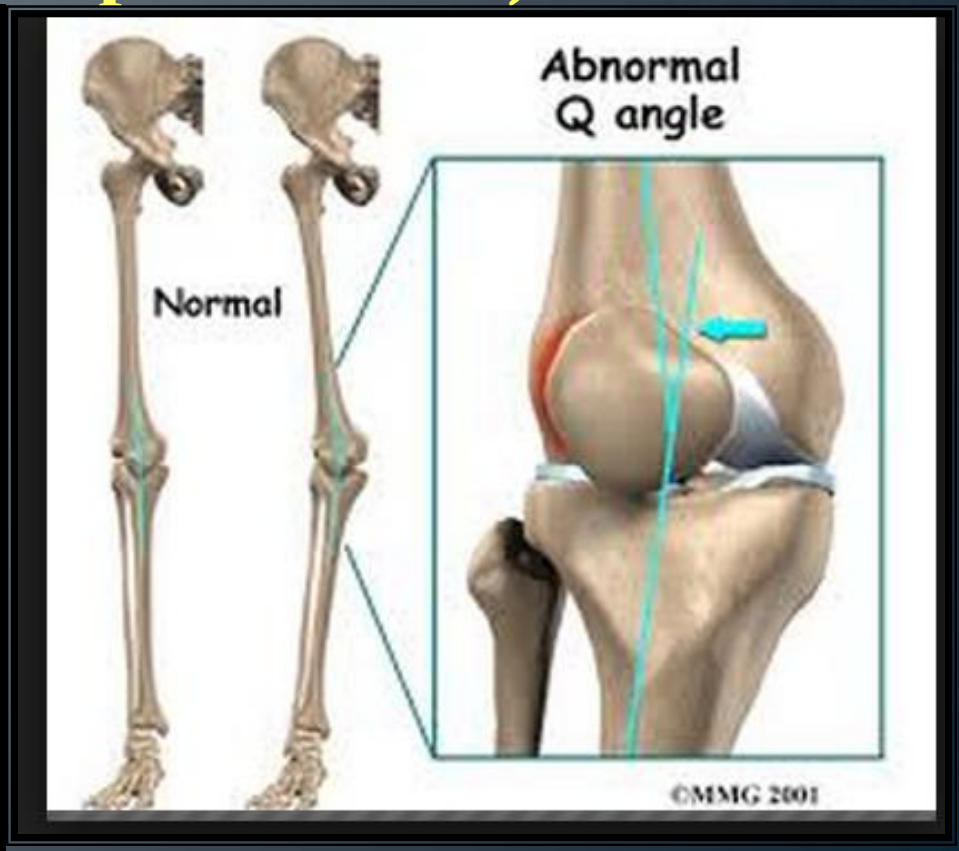


Proximal factors

- Recently, it was reported that functional mal-alignment does not arise in the knee joint but rather by internal rotation and adduction of the femur due to weakness of hip external rotators and abductors. (Petersen et al., 2013).

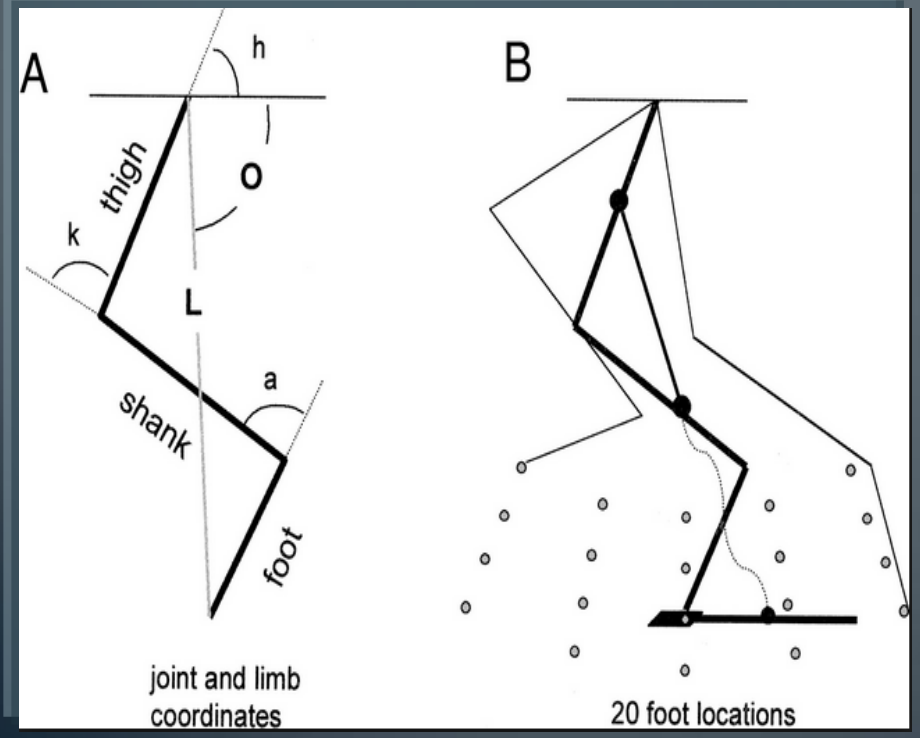


- **Weak hip abductors leads to lateral translatory motion (lateral patellar mal-tracking)**
- **Weak hip external rotators leads to lateral angular motion (lateral patellar tilt).**



Proprioception

- The proprioceptive system contributes to JPS, joint motion sense, and kinesthesia. This includes the sensations of muscle length and tension, joint angles, and changes in these angles (Kars et al, 2009).



Muscle Fatigue

- **Muscle fatigue is defined as the decline in force output capacity after repeated muscle contractions (Hossein et al., 2013).**
- **It has been postulated that, increased fatigability followed by muscle weakness is one of the primary symptoms of patients with different musculoskeletal disorders.**

Muscle Fatigue

- Decline in force generating capacity
- Impaired proprioception
- Altered activation pattern

Purpose of the Study

- **The purpose of the current study was to investigate the effect of induced hip and knee muscle fatigue protocols on :-**
  - **knee proprioception.**
  - **isokinetic peak torque and myoelectric activity of knee extensors, hip abductors and external rotators.**

in patients with patellofemoral pain syndrome .

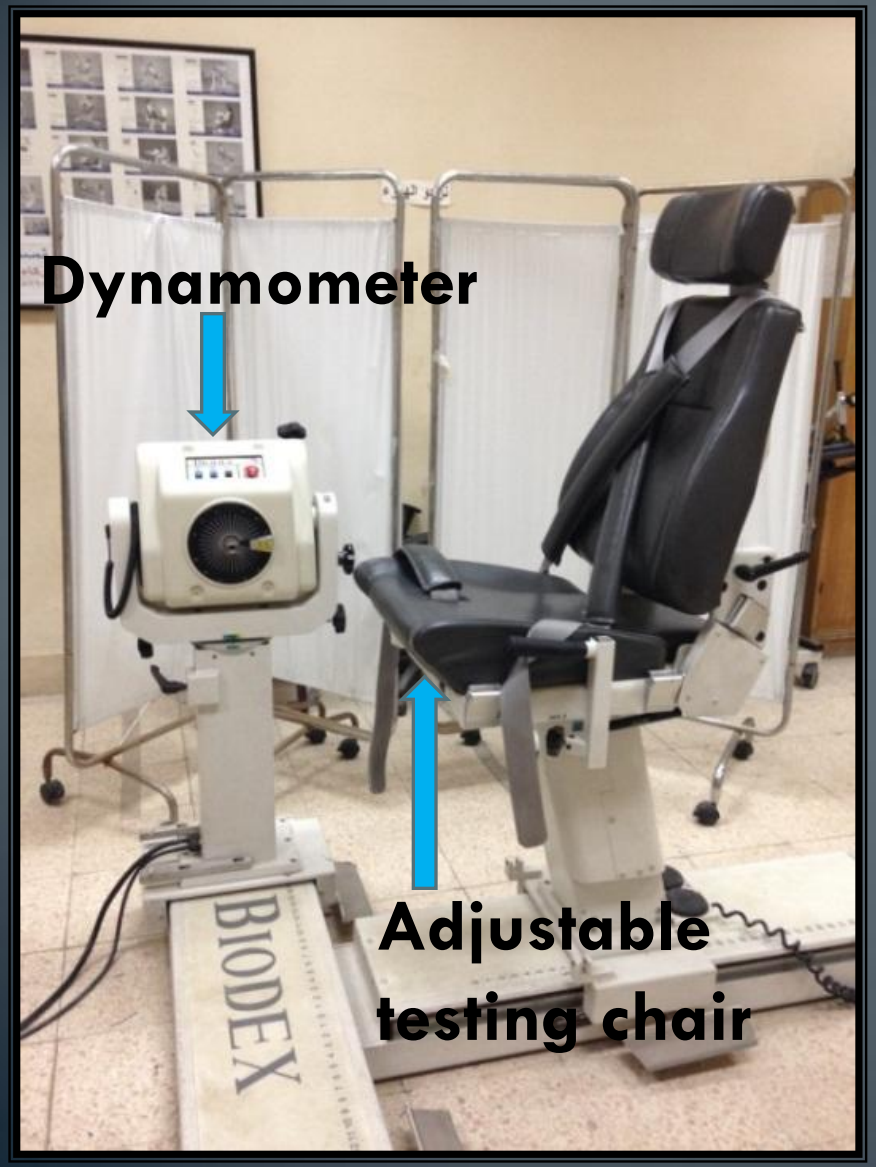
Methodology

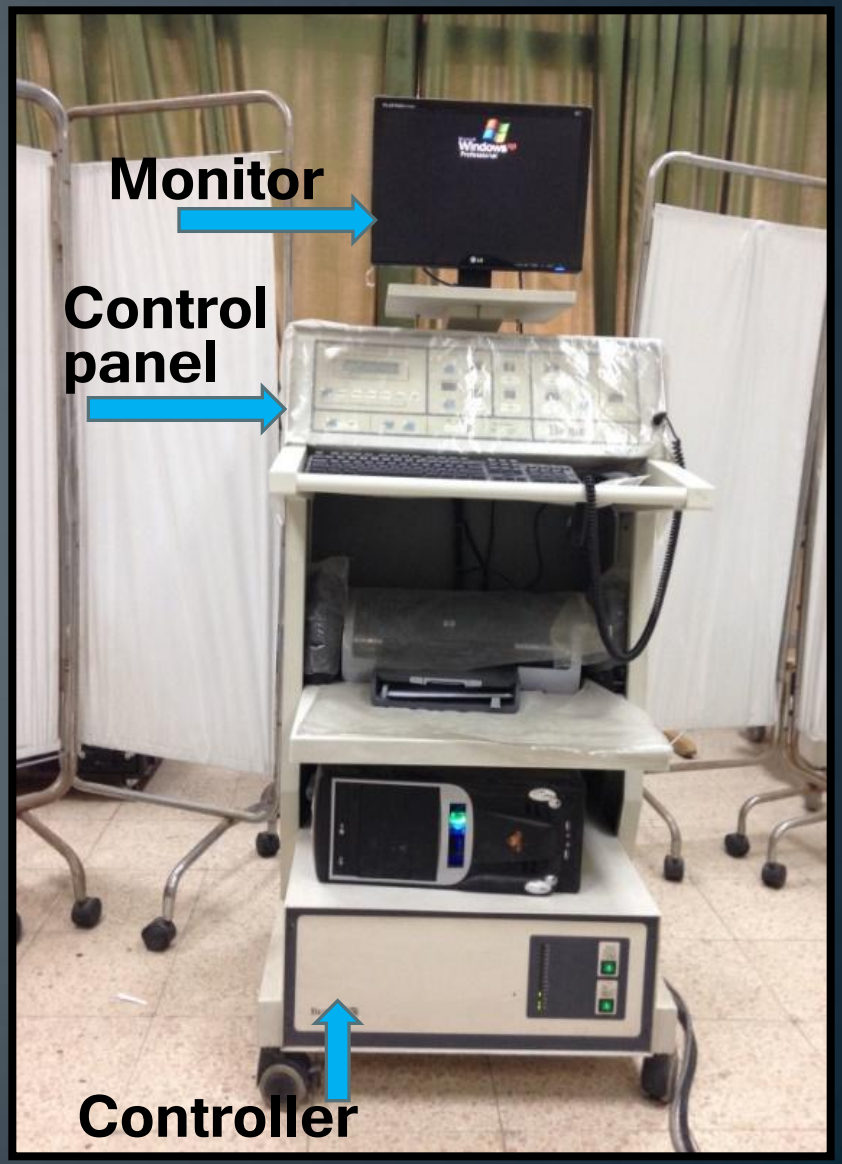
1- Patient Selection

- 15 female patients.
- Anterior or retropatellar knee pain.
- Quadriceps angle (Q angle) ranged between 20° -22°.
- Positive signs of anterior knee pain during the initial physical examination:
  - Functional performance ranged between 65-84 (according to Kujala questionnaire)
  - Knee pain ranged from 3 to 10 according to 10 cm visual analogue scale (VAS)

2- Instrumentation

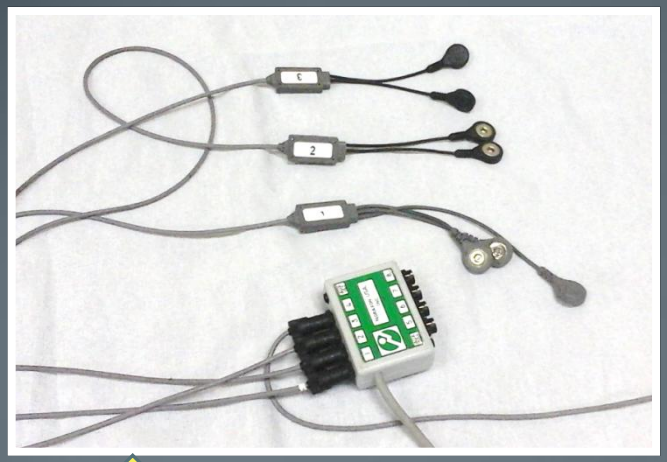
Biodex Isokinetic Dynamometer





2- Instrumentation

Electromyography (EMG) apparatus



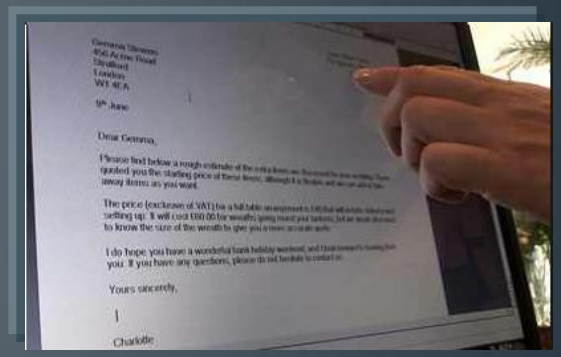
EMG active cable with its input channels

The EMG MyoSystem 1400A

Computer unit

3- Procedures

- This study involved a within-subject experimental design
- At first, The recording data sheet was filled in for each patient then random selection of the two tested fatigue protocols was performed.



Hip Fatigue Protocol

Knee Fatigue Protocol

1) If the chosen fatigue protocol was the hip abductors

The following pre fatigue procedures were done. Firstly EMG electrodes were placed at the motor points of the tested muscles (VMO, VL, and GM muscles)

Electrode placement of VMO and VL

Electrode placement for GM

2) Then, stair stepping task was performed to record myoelectric activity

EMG activity during stair stepping task, (A) Ascending, (B) Descending

3) Knee proprioception and eccentric peak torque of knee extensors were then measured.

Knee proprioception testing

Eccentric knee extensors' peak torque testing

4) And just before conduction of hip fatigue protocol, hip abductors' eccentric peak torque was recorded.

5) Immediately after performing the fatigue protocol, knee proprioception was measured first, then knee extensor and hip abductor muscle strength and finally EMG activity was recorded again.

Eccentric hip abdctors' peak torqe testing

Statistical analysis

- In the current study, two independent variables and five dependent variables were tested.

Data were initially screened for normality assumption as a prerequisite for parametric analysis

1- Normality Tests

2- Skewness and Kurtosis

3- Extreme scores

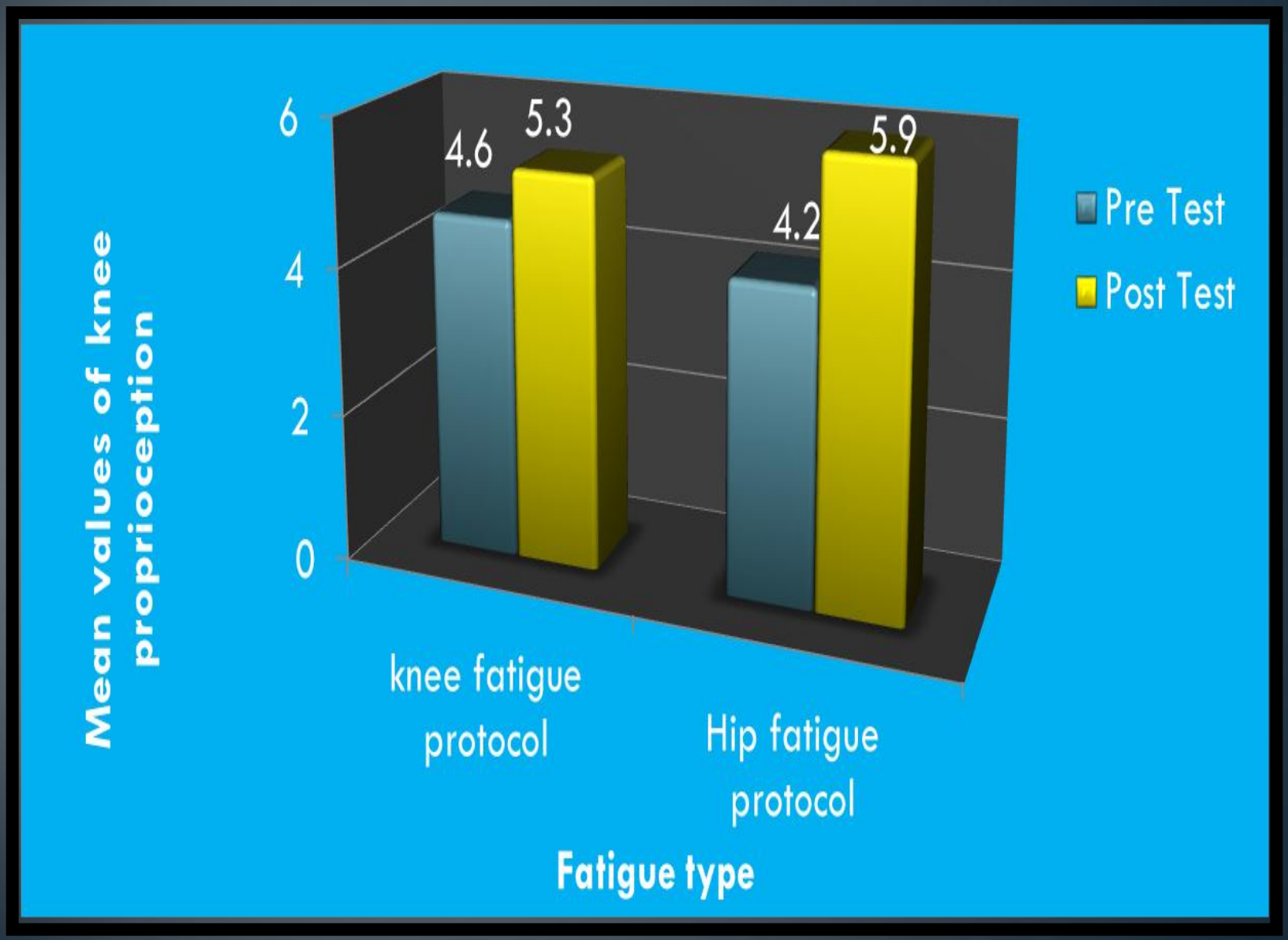
Statistical analysis

Once data were found not to violate the normality assumption, after that, appropriate statistical test was conducted (Two-way within subject MANOVA).

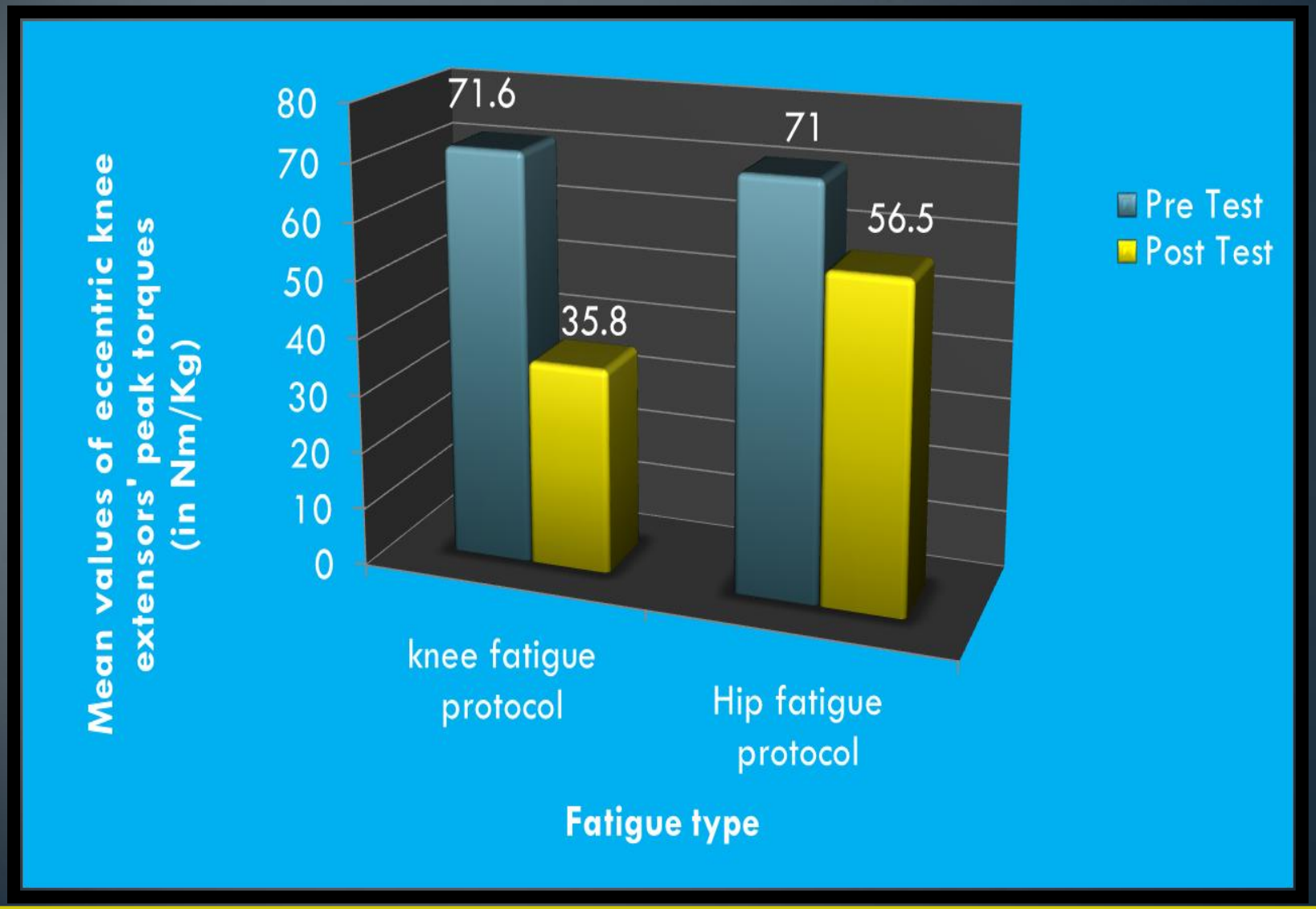
Multiple pairwise comparison tests.
$P<0.05$

Results

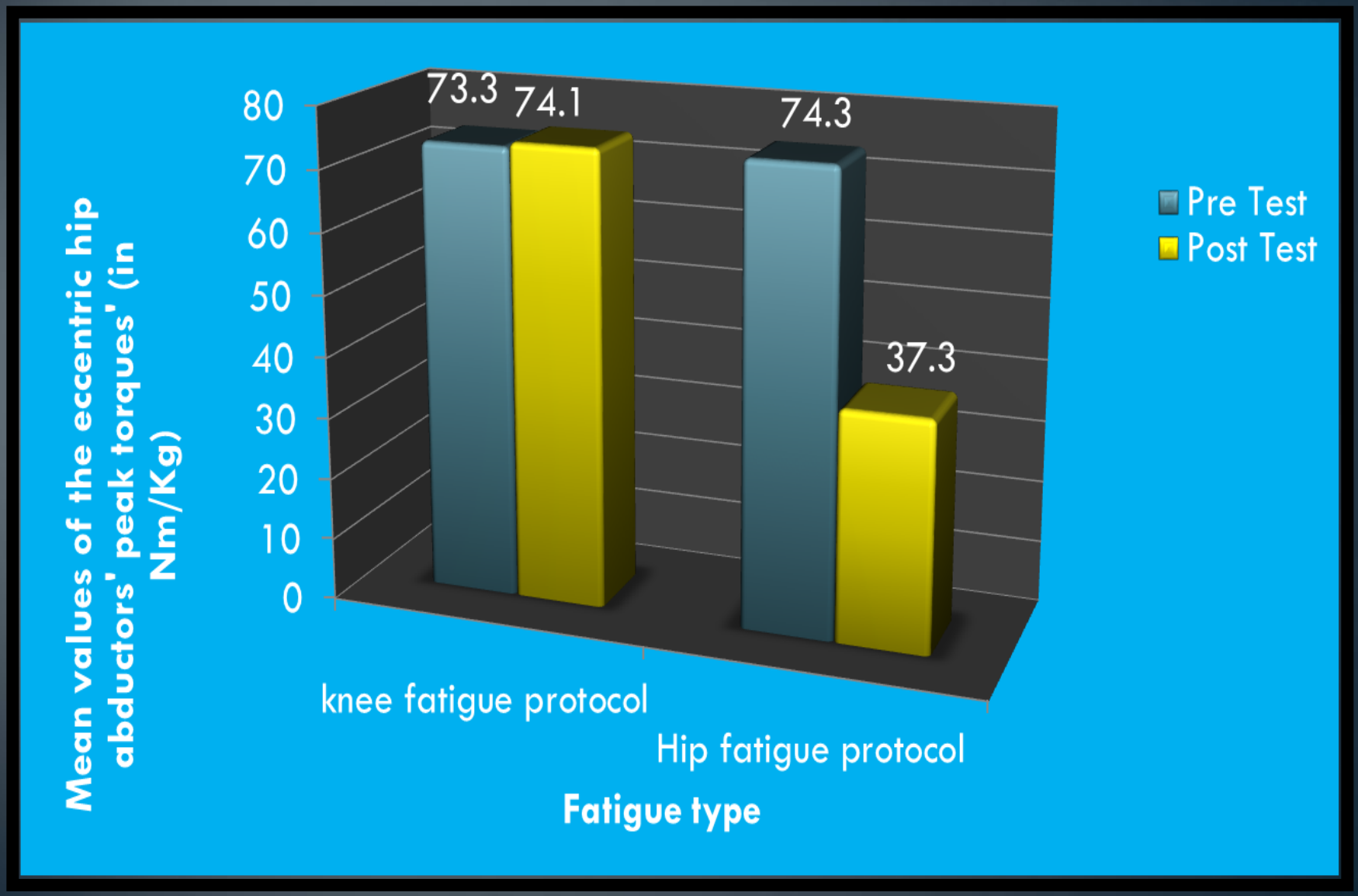
Muscle fatigue and knee proprioception.



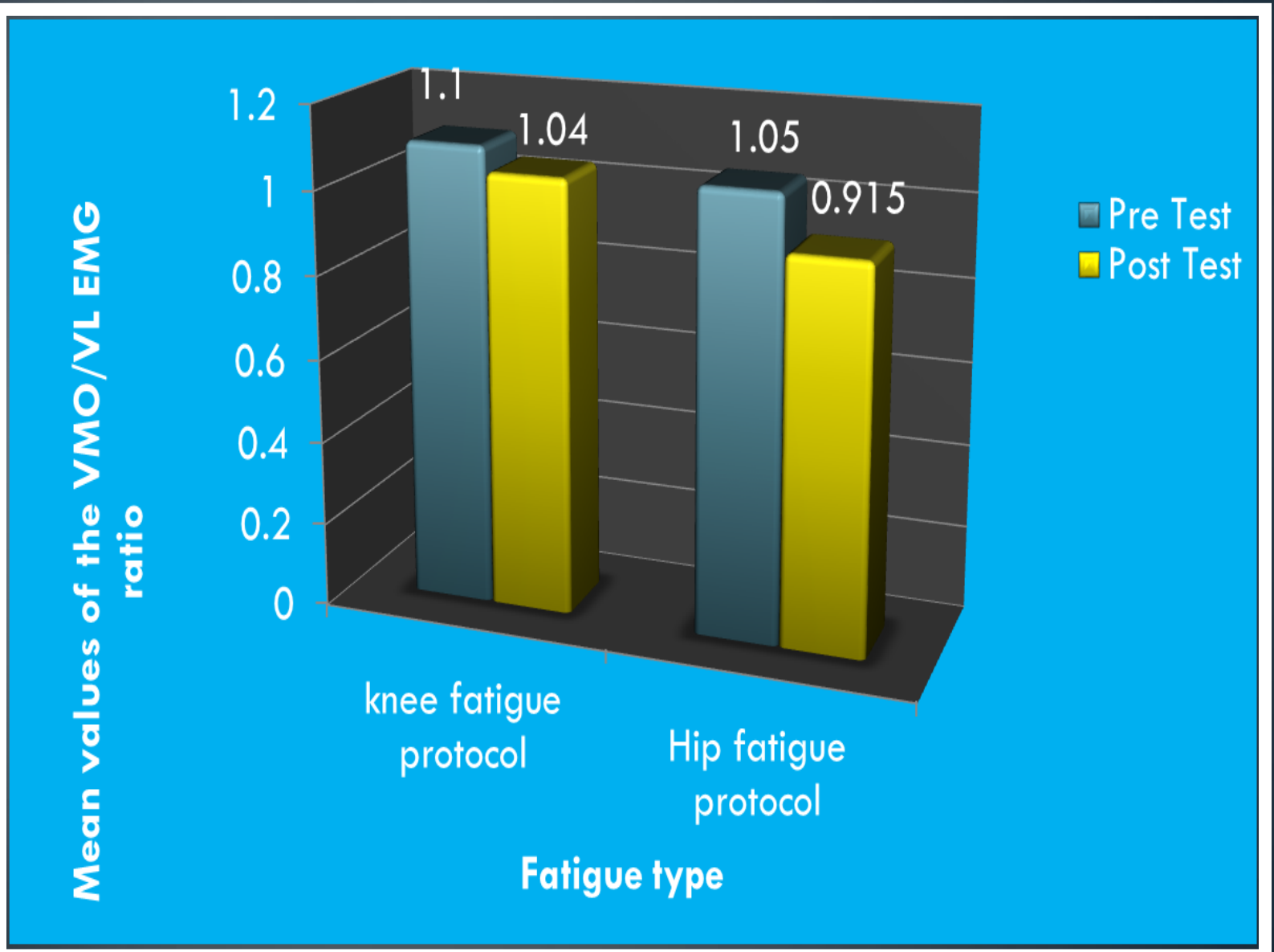
Muscle fatigue and knee extensors' peak torque.



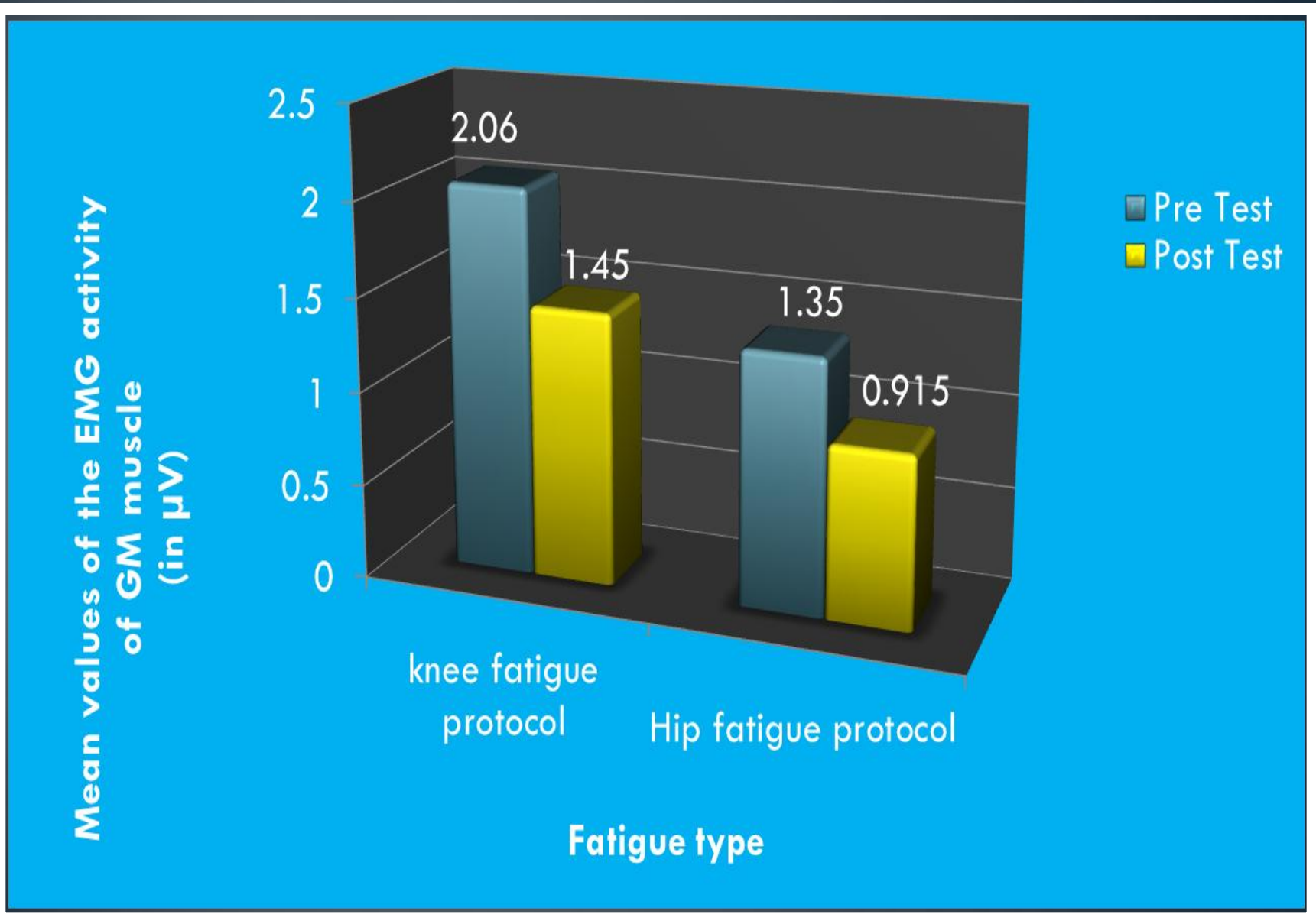
Muscle fatigue and hip abductors' & external rotators' peak torques.



Muscle fatigue and VMO/VL EMG ratio



Muscle fatigue and EMG activity of GM muscle



Two- way within subject MANOVA revealed that

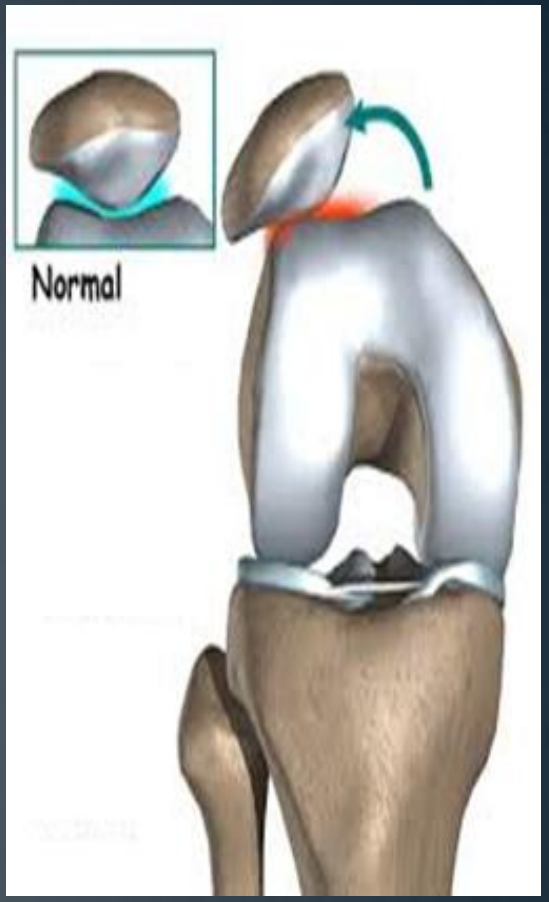
- Eccentric knee extensors' peak torques decreased significantly after hip abductors fatigue protocol compared to pre fatigue condition ($p<0.05$). On the other hand, there was no statistical significance difference in the eccentric hip abductors' peak torques after admitting knee extensors fatigue protocol ($p>0.05$).
- Moreover, no significant difference was found in knee proprioception, (EMG) ratio of vastus medialis obliquus (VMO)/vastus lateralis (VL), and EMG activity of gluteus medius (GM) muscle, after either hip or knee fatigue protocol ($p>0.05$).

Discussion

Knee Peroprioception

- The increase in absolute angular error noted in knee proprioception after fatigue protocol of hip abductors might be attributed to

  - **Greater lateral quadriceps force**



Increase retropatellar stress

Peripatellar plexus dysfunction

Knee Peroprioception

- The insignificant difference in knee proprioception after conducting knee extensors fatigue protocol may be due to
  - Localized fatigue protocol used
  - modulating the number and/ or firing rate of active motor units
  - Agonist muscle fatigue

Eccentric knee extensors' peak torques

Statistically significant reduction in eccentric peak torque of knee extensors after hip abductors fatigue might be attributed to:

* Central fatigue

* Alteration in hip mechanics

Tightness of iliotibial band.

Altered proprioceptive input.

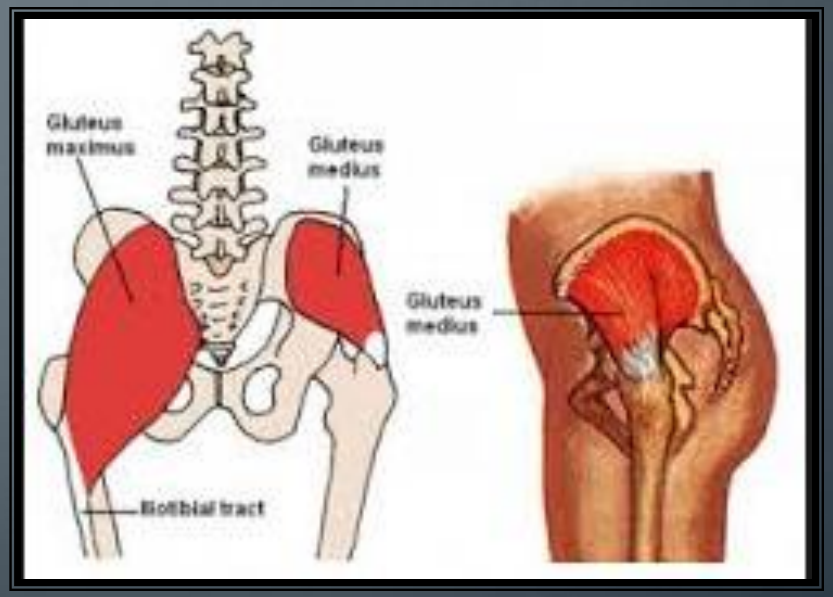
leads to pain and inhibition of knee extensors

Eccentric hip abductors' peak torques

The insignificant difference in hip abductors strength following fatigue of knee extensors might have occurred through:

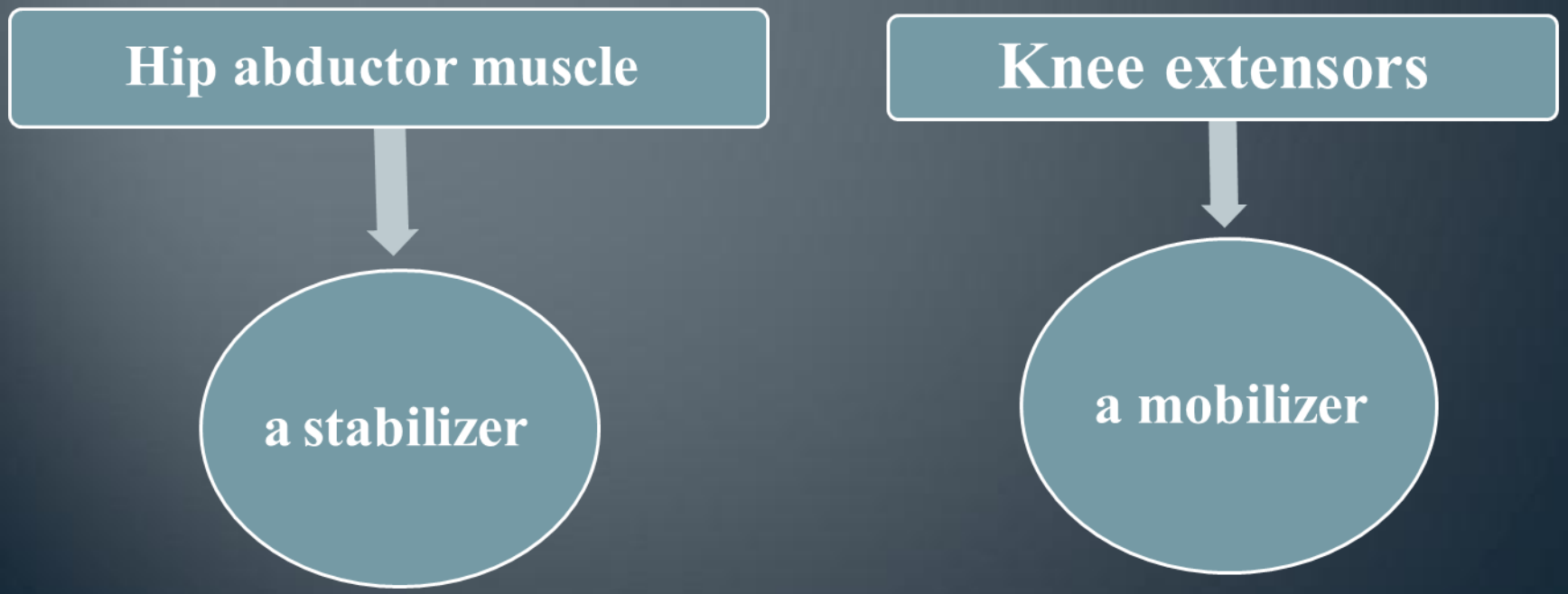
gluteus maximus adjustments

knee joint position during fatigue



In the current study, fatigue of hip abductors decrease knee extensor's strength. On the other hand, fatigue of knee extensors did not have effect on hip muscles.

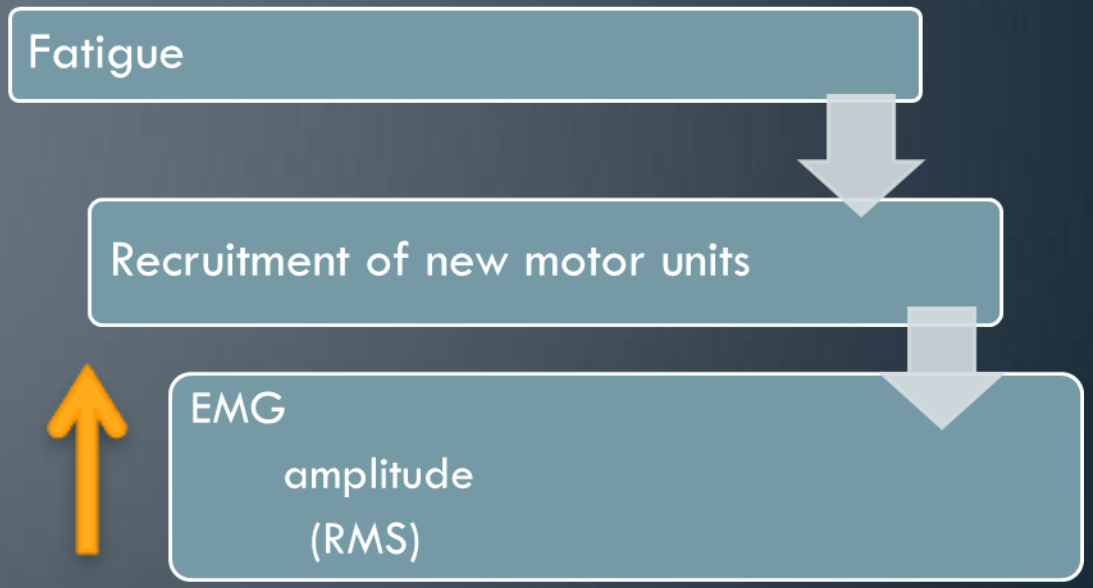
This could relate to different responses of these muscles to fatigue.



VMO/ VL EMG ratio

- **Insignificant difference in VMO/VL EMG ratio might have occurred due to**

increase EMG activity of both VMO and VL muscles when analyzed individually



After knee muscle fatigue → Fatigue of RF > VMO and VL.

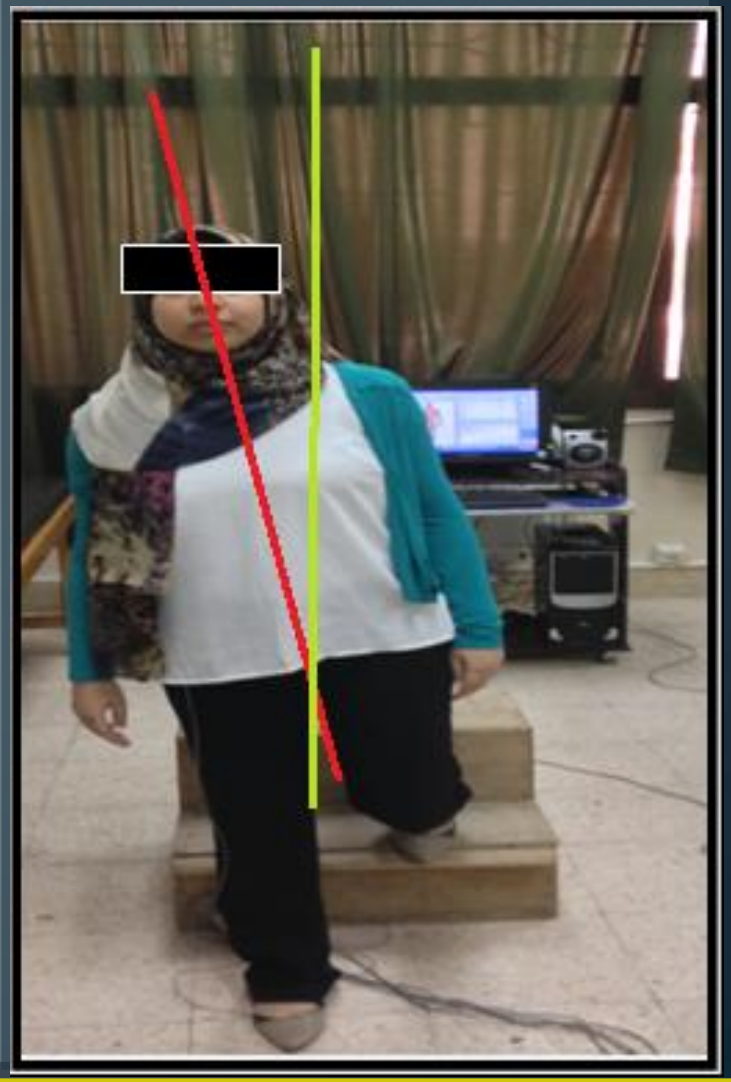
After hip fatigue → decreased knee extensors strength

EMG activity of GM muscle

- **The insignificant difference of EMG activity of GM muscle may be attributed to**

Coactivation response of trunk muscles

Trunk compensation strategy



Conclusion

- Hip abductors fatigue protocol had a great effect on knee extensor muscle strength which supports the proximal strategy in PFPS.
- Therefore, both hip abductor strength and endurance rehabilitation programs are important for knee function in patients with PFPS.
- The insignificant difference found in myoelectric activity of hip and knee muscles suggested that, symptoms of PFPS may result from other causes rather than alteration in myoelectric activity.
- Also, in order to improve knee proprioception in such patients not only endurance exercises are important but also, neuromuscular training is essential

Limitations

1-Inability to infer the findings on the males as our study was conducted on females. Females were examined as they have higher incidence than males (Bijlsma and Knahr, 2007; Litwic et al., 2013).

2-Myoelectric activity recorded during stair stepping task cannot be divided into subphases.

3-Cross talk from nearby muscles cannot be excluded from surface electromyographic data (Fujisawa et al., 2014).

4-Isokinetic dynamometer produces gross movement and cannot analyze torque of specific muscle.

Recommendations

It is recommended to study:

1) The Effect of endurance exercise for hip muscles on knee muscle's strength in patients with PFPS.

2) Difference between the effect of local and general muscle fatigue on the selected parameters.

3) The effect of fatigue exercise on the isokinetic peak torques at different angular velocities.

4) effect of fatigue protocols on trunk kinematics in patients with PFPS.


Thank You
SOTHELEN

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