Combined effect of different surfaces and different squat depths on knee performance EMG study

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ABSTRACT

Background: Good balance in the activation of the Vastus Medialis Obliques and Vastus Lateralismuscles is necessary in order to keep the normalalignment of patellofemoral joint. Therefore, the abnormal relation in the activation pattern of these muscles could alter the dynamics of the patellofemoral joint. **The purpose:** to investigate the effect of different surfaces and different squat depths on Vastus Medialis Obliques and VastusLateralis muscles activities in healthy males. **Subjects and methods:** Thirty healthy males with the following **Inclusion Criteria:** Subject's age ranged from 18-30 years and body mass index from 25 kg/m^2 to30 kg/m^2.the participates performed body weight squat exercise on stable surface and unstable surface with squat depth 50 ^{o} and 80 ^{o} knee flexion. EMG study by using amplitude potential to detect the vastus medialisobliques and vastuslateralis muscles activities on different squat depths that detected by universal goniometer and unstable surface that is used to detect effect of unstable surfaces on vastus medialisobliques and vastuslaterlais muscles activities. **Results** There was a significant increase in the Vastus Medialis Obliques EMG amplitude at 80° knee flexion compared with that at 50° knee flexion (p = 0.0001) and There was a significant increase in the VastusLaterlais EMG amplitude at 80° knee flexion compared with that at 50° knee flexion (p = 0.0001).There was no significant difference in the Vastus Medialis Obliques EMG amplitude at 50° knee flexion between stable and unstable surfaces (p = 0.11). Also, there was no significant difference in the mean Vastus Medialis Obliques EMG amplitude at 80° knee flexion between stable and unstable surfaces (p = 0.23).There was no significant difference in the mean Vastus Laterlais EMG amplitude at 50° knee flexion between stable and unstable surfaces (p = 0.47). Also, there was no significant difference in the mean Vastus LaterlaisEMG amplitude at 80° knee flexion between stable and unstable surfaces (p = 0.52). .**Conclusion:** squat exercise on squat depth 80^{o}knee flexion increases the Vastus Medialis Obliques and Vastus Laterlais muscles activities, unstable surfaces don't change the Vastus Medialis Obliques and Vastus Laterlais muscles activities during squat exercise.

Keywords:vastusmedialisobliques, vastuslateralis, squat depths, unstable surfaces.

Introduction

Unstable Surfaces Training has become very popular among healthy adults and personal trainers working with healthy adults. Although Unstable Surfaces Training is an effective tool used to restore proprioceptive and reactive deficits in the rehabilitation of individuals with ankle and knee injuries [(1)] .the effective application of Unstable Surfaces Training to healthy adults appears to be very limited. Unstable Surfaces Training can be used to activate and train core muscles, specifically in the supine position and with untrained individuals [(2)].

However, adding instability to traditional stable surface exercises may conflict with the benefits derived from stable surface exercise, especially with individuals who are experienced with stable surface exercise[(3)].

Unstable Surfaces are an effective tool, commonly used in rehabilitation, to help reduce recurrence of ankle sprains and anterior cruciate ligament knee injuries [(1)].Although Unstable Surfaces Training has been shown to help restore proprioceptive and reactive deficits in patients with a history of ankle or knee injury, the effect of applying UST to healthy adults has only recently been studied [(4)].

Good balance in the activation of the VastusMedialisObliques and VastusLateralis muscles is necessary in order to keep the aligning normal of patellofemoral joint. Therefore, the abnormal relation in the activation pattern of these muscles could alter the dynamics of the patellofemoraljoint**.** Besides that, it is well-established in the literature that the VastusMedialisObliques /VastusLateralisratio represent the quantitative measurement of the relative participation of VastusMedialisObliques and VastusLateralis muscles during the muscular contraction. According to **McConnell 1996** the VastusMedialisObliques/VastusLaterlais ratio should be 1:1 in subjects clinically healthy and significantly lower for those with patellofemoral pain syndrome. Therefore, the training and VastusMedialisObliques strengthening becomes part of a rehabilitation program in subjects with patellofemoral pain syndrome [(5)].

A squat, performed with the legs fixed on the floor, is a closed-chain exercise and appropriate for activating the lower limb muscles. Accordingly, previous studies have aimed to selectively activate the VastusMedialisObliques muscle by applying squatting. To selectively activate the VastusMedialisObliquesapplied squats on diverse bases of support, such as a hard plate, form, and rubber air disc [(6)].**Irish et al 2010** observed VastusMedialisObliques activation with a squat accompanied by hip joint adduction[(7)].

Squats can be performed at a variety of depths, generally measured by the degree of flexion at the knee. Among many others, categorizes squat depth into the following: Partial squat (0-40 degrees knee angle), Parallel squat (hips parallel to knees or 70-100 degrees knee angle), Deep squat (full range or >100 degrees knee angle) [(8)].

Electromyography (EMG) is a non-invasive method of examining muscle function in vivo (e.g., activation level and fatigue). The median frequency of the EMG power spectrum has been demonstrated to be an effective indicator of fatigue as it is has been reported to be reduced during neuromuscular fatigue and is related to metabolic accumulation. The intensity of EMG was reported to be associated with both fatigue and changes in muscle activation level **[9]**.

EMG is often considered an adequate tool for the assessment of muscle function because integrated EMG is believed to closely parallel muscle force production **[10]**. Perry alludes to this same idea when he states that EMG signal records, after analysis, can estimate resulting muscle force under limited circumstances **[11]**.

Aim of the study: was to investigate the different squat depths and unstable surfaces effect on VastusMedialisObliques and VastusLateralis muscles activities in healthy males during squat **exercise.**

Design of the study: cross sectional design (one shot study).

Subjects, Instrumentations and Methods

Subjects:

This study was conducted in the EMG laboratory of faculty of physical therapy Cairo University to investigate the effect of different surfaces on Vastusmedialisobliqus and Vastuslateralis muscles activities during different squat depths in thirty healthy males.With: **Inclusion criteria** ranged age from 18-30 years. Body mass index from 25 kg/m^2 to 30 kg/m^2 ·**Exclusion criteria** Subjects with cardiovascular disease or neurological disease or musculoskeletal dysfunction. Subjects with previous surgery for lower extremity or for lumber region.Musculoskeletal or neurological disease or disorder affecting normal functioning of the hip, knee or ankle joints, Lower limb deformity.

Instruments:

1. **Electromyography (EMG):** Is often considered an adequate tool for the assessment of muscle function because integrated EMG is believed to closely parallel muscle force production**.**
2. **Goniometer:** Flexible plasliegoniometrer was used to measures the angle of knee joint to determine the squat depth during squat exercise.
3. **rubber air discs** (balance trainer, Harbinger, Canada)**:** Was used as unstable surface.
4. **Generic stopwatch:** Was used to measure the time.

Procedure:

Exercises procedure:

Subjects performed squats for each squat depth (50° and 80° of knee flexion) on the stable surface and on unstable surface. The performance of each squat was controlled with standardized instructions based on a generic stopwatch. Each squat consisted of a 3-second descent (‘Down, Down, Down’), a static contraction for 5 seconds (‘Hold, Hold, Hold, Hold, Hold’) and finally a 3-second ascent (‘Up, Up, Up’). All squats were performed without shoes and with the arms in a comfortable position in front of the chest. Any squat movement that was resulted in the clearance of one side of the foot from the platform was disqualified, and the participants were instructed to repeat that movement.

Measurements of knee flexion, and thus squat depths, were taken with an international standard 32-cm universal goniometer. The goniometer was aligned to specific anatomical landmarks **(12),** with the fulcrum of the goniometer aligned over the lateral epicondyle of the femur; the proximal arm was aligned with the greater trochanter of the femur and the distal arm with the lateral malleolus of the fibula. The assessor kept the goniometer alignment with the mentioned bony landmarks during the active squat.

The 80° of knee flexion was chosen for the 'deep' squat depth as this position is demonstrated at the 'weight acceptance' phase of stair ascent **(13)** before pull-up. The 80° of flexion was chosen for the deepest squat as lower limb muscle activity peaks at 70–90° of knee flexion **(14),** and squat depths greater than this show significant stress on the structures of the knee joint **(15).**

The second squat depth, of 50° knee flexion, was chosen as it offers a good 'spread' of testing positions and falls outside the reported 10° of measurement error associated with goniometry**.** All semi-squats were performed with the feet positioned in 7° of external rotation as this is the normal foot angle during gait **(16)** and is within the range of 5–18° of lower limb external rotation, which is optimal for balance in standing and during gait **(17).**

They performed the squats 3 times with a 10 min break between each trial. The semi squats in both angles (50^o, 80^o) of knee flexion were performed in stable and unstable surface. The stable surface was the ground; the unstable surface was 3-inch diameter, 13-inch thick rubber air discs (balance trainer, Harbinger, Canada).

Statistical analysis:

- Descriptive statistics was carried out to calculate the mean ± SD for all measured variables.
- Two-way MANOVA with repeated measures was carried out to investigate the effect of surface and squat depth on VastusMedialisObliques and VastusLateralis EMG amplitude.
- The level of significance for all statistical tests was set at $p < 0.05$.
- All statistical measures were performed through the statistical package for social studies (SPSS) version 19 for windows.

RESULTS

The purpose of this study was to investigate the combined effect of different surfaces and different squat depths on knee performance in healthy males. Thirty healthy males participated in this study.

Data obtained from the study group regarding VastusMedialisObliques and VastusLateralis EMG activities on stable and unstable surfaces with two different knee depths 50 ^{o} and 80^o were statistically analyzed and compared.

I- General characteristics of the subjects:

Thirty healthy males participated in this study. Their mean ± SD age, weight, height and BMI were 23.46 ± 4.25 years, 73.83 ± 8.06 kg, 169.2 ± 4.35 cm and 25.81 ± 2.32 kg/m² respectively as shown in table 1

Table 1.Descriptive statistics for the mean age, weight, height and BMI of the study group.

	$\bar{x}$ ± SD	Minimum	Maximum	Range
Age (years)	23.46 ± 4.25	18	30	12
Weight (kg)	73.83 ± 8.06	54	87	33
Height (cm)	169.2 ± 4.35	160	177	17
BMI (kg/m²)	25.81 ± 2.32	21.1	29.76	8.66

$\bar{x}$: Mean SD: Standard deviation

- Effect of different surfaces and different squat depths on knee performance:

Two-way MANOVA with repeated measures was conducted to investigate the effect of surface and squat depth on VASTUS MEDIALIS OBLIQUES, VASTUS LATERALIS EMG amplitude and VASTUS MEDIALIS OBLIQUES/VASTUS LATERALIS ratio. There was no significant interaction effect of surface and squat depth (p = 0.35). There was no significant effect of surface (p = 0.38). There was a significant effect squat depth (p = 0.0001). (Table 2).

Table 2.Two-way MANOVA with repeated measures for the effect of surface and squat depth on VASTUS MEDIALIS OBLIQUES, VASTUS LATERALIS EMG amplitude and VASTUS MEDIALIS OBLIQUES/VASTUS LATERALIS ratio:

Two-way MANOVA	
Interaction effect (surface * squat depth)	
$F_{(3,27)} = 1.12$	**p = 0.35**
Effect of surface	
$F_{(3,27)} = 1.06$	**p = 0.38**
Effect of squat depth	
$F_{(3,27)} = 32$	**p = 0.0001**

- **Effect of surfaces and squat depths on VASTUS MEDIALIS OBLIQUES EMG amplitude:**

VASTUS MEDIALIS OBLIQUES EMG amplitude on stable surface

The mean ± SD VASTUS MEDIALIS OBLIQUES EMG amplitude on stable surface at 50° knee flexion was 38.29 ± 13.59 µV while at 80° knee flexion was 50.89 ± 14.29 µV. The mean difference was -12.6 µV. There was a significant increase in the mean VASTUS MEDIALIS OBLIQUES EMG amplitude at 80° knee flexion compared with that at 50° knee flexion (p = 0.0001). (Table 3, figure 1).

VASTUS MEDIALIS OBLIQUES EMG amplitude on unstable surface

The mean ± SD VASTUS MEDIALIS OBLIQUES EMG amplitude on unstable surface at 50° knee flexion was 35.43 ± 11.99 µV while at 80° knee flexion was 48.76 ± 13.54 µV. The mean difference was -13.33 µV. There was a significant increase in the mean VASTUS MEDIALIS OBLIQUES EMG amplitude at 80° knee flexion compared with that at 50° knee flexion (p = 0.0001). (Table 3, figure 1).

Comparison between stable and unstable surfaces

There was no significant difference in the mean VASTUS MEDIALIS OBLIQUES EMG amplitude at 50° knee flexion between stable and unstable surfaces (p = 0.11). Also, there was no significant difference in the mean VASTUS MEDIALIS OBLIQUES EMG amplitude at 80° knee flexion between stable and unstable surfaces (p = 0.23). (Table 3, figure 5).

Table 3. Mean VASTUS MEDIALIS OBLIQUES EMG amplitude at 50 and 80° flexion on stable and unstable surfaces.

VASTUS MEDIALIS OBLIQUES EMG amplitude (µV)	Stable surface	Unstable surface	MD	P-value	Sig
	$\bar{x}$ ±SD	$\bar{x}$ ±SD			
50° flexion	38.29 ± 13.59	35.43± 11.99	2.86	0.11	**NS**
80° flexion	50.89± 14.29	48.76 ± 13.54	2.13	0.23	**NS**
MD	-12.6	-13.33			
P-value	0.0001	0.0001			
Sig	**S**	**S**			

$\bar{x}$: Mean SD: Standard Deviation MD: Mean difference
p value: Probability value S: Significant NS: Non significant

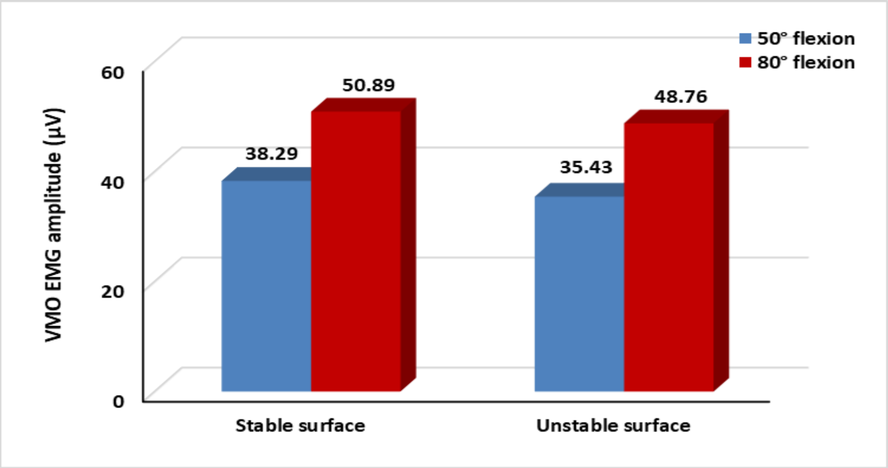

Figure (1). Mean VASTUS MEDIALIS OBLIQUES EMG amplitude at 50 and 80° flexion on stable and unstable surfaces.

- **Effect of surfaces and squat**
- **depths on VASTUS LATERALIS EMG amplitude:**

VASTUS LATERALIS EMG amplitude on stable surface

The mean ± SD VASTUS LATERALIS EMG amplitude on stable surface at 50° knee flexion was 39.39 ± 17.97 µV while at 80° knee flexion was 51.01± 16.82 µV. The mean difference was -11.62 µV. There was a significant increase in the mean VASTUS LATERALIS EMG amplitude at 80° knee flexion compared with that at 50° knee flexion (p = 0.0001). (Table 4, figure 6).

VASTUS LATERALIS EMG amplitude on unstable surface

The mean ± SD VASTUS LATERALIS EMG amplitude on unstable surface at 50° knee flexion was 41.19± 13.5 µV while at 80° knee flexion was 52.47 ± 14.73 µV. The mean difference was -11.28 µV. There was a significant increase in the mean VASTUS LATERALIS EMG amplitude at 80° knee flexion compared with that at 50° knee flexion (p = 0.0001). (Table 4, figure 6).

Comparison between stable and unstable surfaces

There was no significant difference in the mean VASTUS LATERALIS EMG amplitude at 50° knee flexion between stable and unstable surfaces (p = 0.47). Also, there was no significant difference in the mean VASTUS LATERALIS EMG amplitude at 80° knee flexion between stable and unstable surfaces (p = 0.52). (Table 4, figure 2).

Table 4.Mean VASTUS LATERALIS EMG amplitude at 50 and 80° flexion on stable and unstable surfaces.

VASTUS LATERALIS EMG amplitude (μV)	Stable surface	Unstable surface	MD	P-value	Sig
	$\bar{X}$ ±SD	$\bar{X}$ ±SD			
50° flexion	39.39 ± 17.97	41.19± 13.5	-1.8	0.47	**NS**
80° flexion	51.01± 16.82	52.47 ± 14.73	-1.46	0.52	**NS**
MD	-11.62	-11.28			
P-value	0.0001	0.0001			
Sig	**S**	**S**			

$\bar{X}$: Mean SD: Standard Deviation MD: Mean difference
p value: Probability value S: Significant NS: Non significant

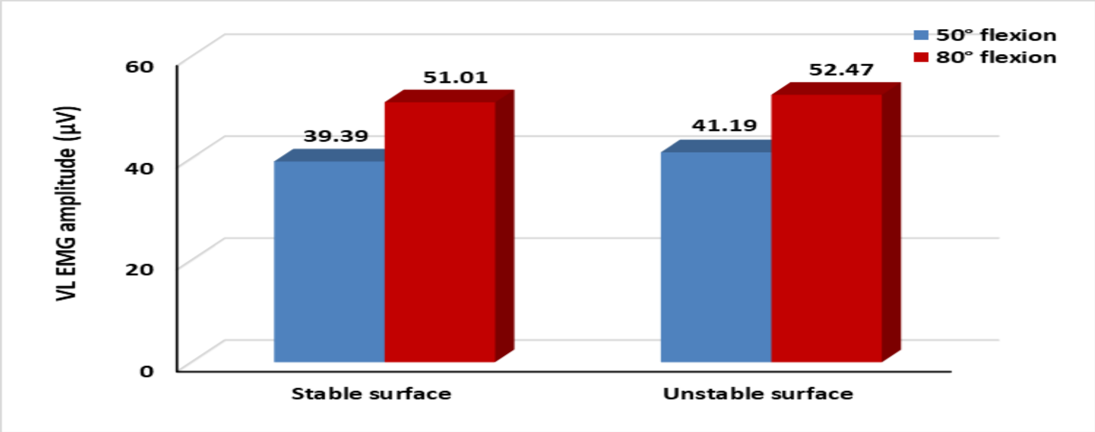

Figure (2). Mean VASTUS LATERALIS EMG amplitude at 50 and 80° flexion on stable and unstable surfaces

DISCUSION

The aim of the study was to investigate the different squat depths and unstable surfaces effect on VastusMedialisObliques and VastusLateralis muscles activities in healthy males during squat exercise.

Surfaces activity EMG was recorded from VastusMedialisObliques muscle and VastusLateralis muscles of the dominant limb during three repetitions of squat exercises on different squat depth (50o, 80o) knee flexion on stable and unstable surface.

The average intensity of the rectified and smoothed EMG activity from each activity was normalized to that elected in a maximal quadriceps exercises. The ratio of normalized VastusMedialisObliques: VastusLateralis EMG intensity levels were calculated. The collected data were statically analyzed by descriptive statistics; Two-way MANOVA with repeated measures was carried out to investigate the effect of surface and squat depths on VastusMedialisObliques and VastusLateralis EMG amplitude.

Use of the maximal isometric EMG activity as the normalizing factor allows expression of activity in as easily understandable ratio and has been shown to provide better reliability.

The results of this study showed that There was a significant increase in the VastusMedialisObliques EMG amplitude at 80° knee flexion compared with that at 50° knee flexion ($p = 0.0001$) and There was a significant increase in the VastusLaterlais EMG amplitude at 80° knee flexion compared with that at 50° knee flexion ($p = 0.0001$).

There was no significant difference in the VastusMedialisObliques EMG amplitude at 50° knee flexion between stable and unstable surfaces ($p = 0.11$). Also, there was no significant difference in the mean VastusMedialisObliques EMG amplitude at 80° knee flexion between stable and unstable surfaces ($p = 0.23$).

There was no significant difference in the mean VastusLaterlais EMG amplitude at 50° knee flexion between stable and unstable surfaces ($p = 0.47$).Also, there was no significant difference in the mean VastusLaterlais EMG amplitude at 80° knee flexion between stable and unstable surfaces ($p = 0.52$).

Saeterbakken and Fimland 2013 investigated EMG activity in the rectus femoris, vastuslateralis, vastusmedialis, biceps femoris, soleus, rectus abdominis, external oblique and erector spinae muscles during the free squat on the ground and different US (Power board®, BOSU® and Balance Cone®). Only the rectus femoris exhibited higher EMG activity on a Stable Surface. In the other muscles, no differences were observed between the stable surface and unstable surface and that support our results[(18)].

Anderson and Behm 2002 identified that unstable condition decreased force generation but did not change muscle activations of upper body during bilateral contractions that support our results that's no change in muscles activity on stable and unstable surface [(19)].

In the other parameter squat depthTang et al. 2001investigated the activity of the quadriceps muscle at various knee bending angles, and reported that the VastusMedialisObliques/VastusLateralis ratio was highest at the 60° knee flexion angle. The finding of this study was also consistent with those of the previous studies indicating that as the angle increased on a stable or an unstable surface, the muscle activation of the VastusMedialisObliques and VastusLateralisalso increased and that the VastusMedialisObliques/VastusLateralis muscle activation ratio was 1.06 and 0.93, respectively, when the knee joint flexion angle was 60°and that support our results[(20)].

This was attributed to the fact that as the angle increases during a squat exercise, the moment arm of the quadriceps muscle and the muscle activity also increase, and that the selective activation of the VastusMedialisObliques was caused by the involvement of various hip joints when the knee joint flexion angle was at its highest (at 60°) and that agree with our results.

The decision to test several squat depths was based on the theory that the length of the muscle will influence the tension (force) it is able to produce and thus may result in changes in the relative activation of VastusMedialisObliques and VastusLateralis.

In contrast to our results, McBrideet al. 2006reported greater EMG activity in the vastuslateralis and the vastusmedialis during the isometric free squat on two balance disks with similar muscle activation for the biceps femoris and medial head of the gastronomies[(21)].

Kang and Hyong2012 reported the reason for the higher activity of the VastusMedialis Oblique sparticularly enhanced on rubber discs can be the fact that unstable surfaces make maintaining ankle joint positions difficult, so that more efforts required maintaining posture[(22)].

Kunjal and Madhuri2015 reported Squat exercises on unstable surfaces allow optimal activation of the VastusMedialis Oblique muscle. Thus to activate the VastusMedialisObliques unstable surfaces that are highly unstable should be selected[(23)].

It was reported in Anderson and Bhem’s 2005 research that when squat exercise was conducted on a unstable surface, VastusMedialisObliquesmuscle activation declined more than when it was conducted on a stable surface, due to the ankle strategy for posture control and it is against the findings of this study[(24)].

This suggested that as knee bending increased on an unstable surface, all muscles passing the body segments co-contracted to maintain the balance between the truncus and the lower limbs. To overcome the instability of the front and back, and the right and left feet, the distal part rather than the quadriceps muscle was used and posture was maintained by using the ankle and triceps muscles, which is considered to have reduced the intensive activation of the VastusMedialisObliques.

Cressey etal,2017 demonstrated that just the addition of Unstable Training to an effective stable surface training program can attenuate strength, power, and performance improvements. This may be the result of conflicting neuromuscular recruitment patterns of concurrent stable surface training and Unstable Training[(3)]

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Conclusion:

Squat exercise on squat depth 80o knee flexion increases the VastusMedialisObliques and VastusLaterlais muscles activities.

Unstable surfaces don't change the VastusMedialisObliques and VastusLaterlais muscles activities during squat exercise.

REFERENCES

1. **Caraffa A, Cerulli G, Projetti M, Aisa G, and Rizzo A. (1996).**Prevention of anterior cruciate ligament injuries in soccer. A prospective controlled study of proprioceptive training. Knee Surg Sports TraumatolArthrosc 4: 19-21.
2. **Norwood JT, Anderson GS, Gaetz MB, and Twist PW. (2007).**Electromyography activity of the trunk stabilizers during stable and unstable bench press. J Strength Cond Res 21: 343-347.
3. **Cressey EM, West CA, Tiberio DP, Kraemer WJ, and Maresh CM.(2007).**The effects of ten weeks of lower-body unstable surface training on markers of athletic performance. J Strength Cond Res 21: 561-567.
4. **Webster JM, Jespersen SM, Nielsen KD, and Neumann L.(1996).**Wobble board training after partial sprains of the lateral ligaments of the ankle: A prospective randomized study. J Orthop Sports PhysTher 23: 332-336.
5. **McConnell J. (1996).** Management of patellofemoralproblems. Man Ther, 1: 60–66. 47.
6. **In HyoukHyong and Jong Ho Kang.(2013).** Activities of the VastusLateralis and VastusMedialis Oblique Muscles during Squats on Different Surfaces. J PhysTher Sci. 2013 Aug; 25(8): 915–917.
7. **Irish S, Millward A, Wride J, Haas B, Shum G.(2010).** The effect of closed-kinetic chain exercises and open-kinetic chain exercise on the muscle activity of vastusmedialis oblique and vastuslateralis. Journal of Strength and Conditioning Research; 24(5): 1256–1262.
8. **SchoenfeldBJ :(2010)** Squatting kinematics and kinetics and their application to exercise performance. J Strength Cond Res, 24: 3497–3506.
9. **De Luca C (2000):** The use of surface electromyography in biomechanics. *Journal of Applied Biomechanics,13*, 135-63.

10. **Hanten WP and Schulthies SS (1990):** Excesses effect on electromyogrophic activity of vastusmedialis oblique and vastuslateralis muscle. Physther. 70 (9): 561-565.
11. **Perry J (1992):** Gait Analysis, Normal and Pathological Function.Thorofare, Slack Inc, pp.381-411.
12. **Norkin C, White D. (2006)** Measurement of Joint Motion: A Guide to Goniometry. Philadelphia: FA Davis 1995 Panagiotopoulos E, Strzelczyk P, Herrmann M, Scuderi G. Cadaveric study on static medial patellar stabilisers: the dynamizing role of the vastusmedialisobliquus on medial patellofemoral ligament. Knee Surgery, Sports Traumatology, Arthroscopy; 14 7–12.
13. **Levangie P, Norkin C.(2006)** Joint Structure and Function: Comprehensive Analysis. Philadelphia, PA: F.A. DavisCo.
14. **Sczepanski T, Gross M, Duncan P, Chander M.(1991)** Effect of contraction type, angular velocity, and arc of motion on VASTUS MEDIALIS OBLIQUES:VASTUS LATERALIS EMG ratio. Journal of Orthopaedic and Sports Physical Therapy; 14(6): 1552–1566.
15. **Escamilla RF, Fleisig GS, Zheng N, et al.(2001):** Effects of technique variations on knee biomechanics during the squat and leg press. Med Sci Sports Exerc, , 33: 1552–1566.
16. **Murray M. Gait as a total pattern of movement. (1967).** American Journal of Physical Medicine; 46: 290.
17. **Edwards J, Greene K, Davis R, Kovacik M, Noe D, Askew M. (2004)** Measuring flexion in knee arthroscopy patients. The Journal of Arthoplasty; 19(3): 329–372.
18. **Saeterbakken AH, Fimland MS.(2013)**Electromyographic activity and 6RM strength in bench press on stable and unstable surfaces. ***J Strength Cond Res.***; 27:1101-1107.
19. **Behm, DG, Anderson, K, and Curnew, RS.(2002)** Muscle force and activation under stable and unstable conditions. J Strength Cond Res16: 416–422.
20. **Tang S, Chen C, Hsu R, Chou S, Hong W, Lew H.(2001).**Vastusmedialisobliquus and vastuslateralis activity in open and closed kinetic chain exercises in patients with patellofemoral pain syndrome: an electromyographic study. Archives of Physical Medicine

and Rehabilitation; 82(10): 1441–5.

21. **McBride JM, Cormie P, Deane R.(2006)** Isometric squat force output and muscle activity in stable and unstable conditions. ***J Strength Cond Res.***; 20:915-918.
22. **Kang JH, Hyong IH. (2012)** Analysis of electromyographic activities of ankle muscles at different levels of instability of unstable surfaces. J PhysTherSci,; 24:1333-1335.
23. **Kunjal Parekh, Madhuri Gaur.(2015)** A STUDY TO DETERMINE THE ELECTROMYOGRAPHIC ACTIVITY OF VASTUS MEDIALIS OBLIQUE MUSCLE DURING SQUATS ON DIFFERENT SURFACES. Int J Physiother Res 2015; 3(4):1180-1183.
24. **Anderson, KG and Behm, DG. (2005)** the impact of instability resistance training on balance and stability. Sports Med 35: 43–53.

الملخص العربي

تاثير الاسطح المختلفة واوضاع القرفصاء المختلفة على النشاط العضلي الكهربائي لاداءالركبة

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الغرض: كان الغرض من هذه الدراسة هو دراسة تأثير الأسطح المختلفة والأعماق القرفصاءية المختلفة على نشاط العضلة المنحنية الوسطية والعضلة الخارجية للعضلة الرباعية أثناء ممارسة تمرين القرفصاء.

الهدف من البحث: 30شخص من الذكورالاصحاء شاركت في هذه الدراسة. وكانت الاشخاص المشاركون يتم اختيارهم وفقا لما يلي: معايير التضمين شملت الاشخاصالاصحاء. تراوح عمر الشخص من سن 18 إلى 30 سنة .الاشخاص لديهم ما يكفي من المعرفية ومتعلمين بما فيه الكفاية لفهم متطلبات الدراسة. مؤشر كتلة الجسم من 25 كجم/م^{2}أقل من 30 كجم / م^2. معايير الاستبعاد المرضى الذين يعانون من أمراض القلب والأوعية الدموية أو أمراض الجهاز العصبي أو خلل العضلات والعظام والمرض العضلي الهيكلي أو العصبي أو اضطراب يؤثر على الأداء الطبيعي لمفاصل الورك أو الركبة أو الكاحل أو تشوهات الطرف السفلي.

طريقة الدراسة: 30 شخص من الذكورالاصحاء يقومون بممارسة تمارين القرفصاء على سطح ثابت و سطح غيرثابت على عمقي القرفصاء 50^o و80^o من انحناء مفصل الركبة.تم قياس النشاط الكهربائي للعضلتين المراد اختبارهم في اوضاع القرفصاء50^o و80^o على سطح ثابت و سطح غير ثابتوتم تحديد زاوية انحناء الركبة في وضع القرفصاء عن طريق مقياس مدى الحركة .

النتائج:النشاط العضلي لكلتا العضلتين العضلة المنحنية الوسطية والعضلة الخارجية للعضلة الرباعية في عمق القرفصاء 80^oاعلى من عمق القرفصاء 50^o ومتساوي على السطح الثابت والغير ثابت.

الخلاصة:عمق القرفصاء 80^oيعمل على زيادة الانشطة العضلية لكلتا العضلتين العضلة المنحنية الوسطية والعضلة الخارجية للعضلة الرباعيةاكثر من عمق القرفصاء 50^o و الأسطح الثابتة والغير ثابتة متساوية في تاثيرها على نشاط كلتا العضلتينعند ممارسة تمرين القرفصاء .لذا عند ممارسة تمرين القرفصاء يفضل ممارسته عند عمق قرفصاء 80^oمن انحناء مفصل الركبة لزيادة الانشطة العضلية لكلتا العضلتين العضلة المنحنية الوسطية والعضلة الخارجية للعضلة الرباعية.

الكلمات الدالة:العضلة المنحنية الوسطية ،العضلة الخارجية ، أعماق القرفصاء،الاسطحالغير ثابته.