

## ORIGINAL ARTICLE

# Effect of Sling Open Chain Knee Extension Exercise on Q-Angle and Jumping Performance among College Volleyball Play

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**ABSTRACT**

**Background:** Sports knee injury usually occurs by an uncontrolled movement of Lower extremity. Athletes with significant external tibial torsion and knee flexion more than 90 degrees during take-off are at risk for developing Patellofemoral pain syndrome. SOCKE exercise is designed for quadriceps muscle training and has a high recruitment impact on the VMO, thereby help to alter the Q-angle mechanism in knee pain. Objective of this study is to find out the effects of sling open chain knee extension exercise in altering the Q angle and improving their jumping performance in volleyball players among college students.

**Method:** This Experimental study involves 30 volley ball players & they were divided into 2 groups (experimental & control). Experimental group received SOCKE Exercise along with conventional knee exercise & Control group received only conventional knee exercise with treatment duration of 6 weeks. Pre & post-test outcome measures of VJT and Q-angle were assessed.

**Results:** Pre-test and post-test values obtained were analysed using paired & unpaired 't' test for 28 degrees of freedom at a 5% level of significance. The mean value of VJT and Q-ANGLE in experimental group 3.00 & 3.07 shows more significant than mean value of VJT and Q-ANGLE control group 2.33 & 2.47.

**Conclusion:** This study concludes that Experimental group who received sling open chain knee extension exercise shows greater statistically significant in reducing Q-angle and improving the jumping performance than control Group who received only Conventional knee exercises.

**KEYWORDS**

• Volley ball players • SOCKE • Q-angle • VJT

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## INTRODUCTION

Volleyball is known as one of the most thrilling sports, with the FIVB (Federation Internationale de Volleyball) representing over 150 nations and nearly 200 million professional players worldwide.<sup>(1)</sup> The knee joint, which consists of the tibiofemoral and patellofemoral joints, is one of the most essential but complicated joints in the human body.<sup>(2)</sup> The patella's location is determined by the following factors: tilt, rotation, shift, and Q angle. The VMO muscle maintains the normal patellar shift, which leads to a normal Q-Angle and also prevent the knee cap from slipping laterally and tracking improperly at the patellofemoral joint. Overall quadriceps strength helps to normalize patellar shift and Q angle.<sup>(3)</sup> An acute knee injury usually occurs by an uncontrolled movement of Lower extremity. Patellar tendon starts close to the bottom of the kneecap, which is the most prevalent location for discomfort. The athletes create more force during vertical jumping appear to be the most vulnerable. Athletes with significant external tibial torsion and knee flexion more than 90 degrees during take-off are also at risk.<sup>(4)</sup> The collected injuries showed that knee injuries are the most common anatomical position prone to injuries in males (12.52% right, 11.89% left) and females (11.53% right and (11.25) left knees. In both male and female groups, the chi square test revealed a significant connection between Q angle and injury prevalence in the right and left legs.<sup>(5)</sup> An increase in the Q angle over the normal range indicates extensor mechanism misalignment and has been linked to patellofemoral pain syndrome, knee joint hypermobility, and patellar instability. An improper Q angle may also alter neuromuscular response and quadriceps reflex response time, which is an etiological component in patellofemoral pain syndrome.<sup>(6-5)</sup> The Q angle was measured when the subject was supine and the pelvis was square. The legs were extended at the knee joint, the quadriceps muscle was relaxed, and the feet placed in a neutral rotation posture with the toes pointing directly upwards and the feet perpendicular to the resting surface. The ASIS, CP, and center of the TT have been drawn with the following bone landmarks: the contour of the patella was sketched using a marker pen. The CP was established as the point of junction of the patella's maximal vertical and

transverse diameters. The center of the TT was identified as the point of maximal prominence, and a straight edge of a measuring tape was used to create a line from the CP to the ASIS. Another line connected the TT with the CP, and the second line was extended uphill. The angle produced by the two lines above was established as the Q angle, and it was measured with a Goniometer.<sup>(6)</sup> Jumping skill is essential for volleyball success. Providing a competitive edge in both offense (gaining a great height to hit above the block or a better angle of attack) and defense (gaining a higher block position to boost vertical jump). Loaded jumping is frequently used to develop lower-body strength and power. This has been demonstrated to occur, and as a result, this increase appears to contribute to a little rise in vertical jump height.<sup>(9)</sup> The vertical jump is used to estimate sport performance capabilities and physical fitness in children, the elderly, non-athletic individuals, and injured individuals. A popular field test uses the Sargent vertical jump with counter movement; new low-cost, easy-to-use tools are available.<sup>(10)</sup> When compared to the combination of traditional knee exercises and knee weight bearing exercises, Mahnoor Asif *et al.* found that the combination of knee strengthening and conventional knee exercises is equally effective in improving pain, functional level, and knee strength in sprinters with PFPS.<sup>(11)</sup> According to Wen-Dien Chang *et al.*, the SOCKE exercise is designed for quadriceps muscle training and has a recruitment impact on the VMO. The SOCKE exercise has a more favorable impact than the SCCKE exercise.<sup>(12)</sup> As a result, the purpose of this study was to figure out the effect of sling open chain knee extension exercise on 'Q' angle and jumping performance in volleyball players.

## NEED AND AIM OF THE STUDY

Both Sling open and closed chain exercise can enhance VMO muscle contraction in PFSP patients, and the SOCKE exercise has a more favorable effect on the VMO to VL ratio than the SCCKE exercise. To all of our knowledge, there has been no research on the effect of the SOCKE exercise on Q angle and jumping performance in volleyball players. Therefore, need of research is to find out the effect of sling open chain knee extension exercise on Q angle and jumping performance among college level

volleyball players. Aim is to find out the effect of sling open chain knee extension exercise on Q angle and jumping performance in volleyball players among college students.

### OBJECTIVE OF THE STUDY

To find out the effect of sling open chain knee extension exercise in altering the Q angle and improving their jumping performance in volleyball players among college students.

### MATERIALS & METHODOLOGY

This Experimental study involves 30 volleyball players from Sri Venkateshwaraa college of Engineering & Technology & they were divided into 2 groups (experimental & control). Experimental group received SOCKE Exercise along with conventional knee exercise & Control group received only conventional knee exercise. The subjects were selected based on the inclusion criteria. Both gender & age group between 18-26 years. Inclusion criteria: 'Q' angle greater than 20° in women & 10° in men, Voluntary participants, Vertical jump test lesser than 30 cm. Exclusion criteria: Flat foot, Ligamentous laxity, Medial patellar shift, Injury to lumbar region, Osteoarthritis, Rheumatoid arthritis, Patellar instability, Dislocation or subluxation, Meniscal injury, Recent knee surgery (within 2-3 months), Patellar tendon pathology. The pre-test & post-test values of the subjects were assessed using Vertical jump test, Q-Angle by goniometer measurement. Outcome measures like Jumping performance, Q-angle was used in this study.

### PROCEDURE

Subject who fulfilled the inclusion criteria were included for this study. The benefits of the intervention were explained to the patient and a written informed consent was taken. Here conventional exercise used in both groups. The subjects were randomly allocated into 2 groups.

### EXPERIMENTAL GROUP

**Sling open chain knee extension exercise:** Subject was asked to lay on the floor with both hands at the sides of the body. A sling was placed on the popliteal fossa. Participants were requested to straighten their lower legs from a knee flexion angle of 60°. (Fig. 1)



(a) Starting position



(b) Ending position

Fig. 1: SOCKE Exercise

### CONTROL GROUP

1. **Single leg Gluteal bridge:** Lie on back with the knees shoulder-width apart, feet flat on the ground, and knees bent. Make sure that the toes are straight ahead and heels are 6-8 inches apart from your glutes. Place your arms flat on each side of you, palms toward the ceiling. Ask the subject to Slowly raise their hips, engage your glutes, and squeeze the abdomen. A perfect glutes bridge consists of elevating your hips until your torso makes a straight line from your shoulder up to your knee. (Fig. 2)



Fig. 2: Single Gluteal Bridge

2. **Half squat:** Subject was asked to stand with arms extended forward parallel to the floor & ask to Squat down by bending your hips back while allowing your knees to bend forward, keeping your back straight and knees pointed same direction as your feet. Descend until halfway to your thighs, reaching parallel to the floor. (Fig. 3)



Fig. 3: Half Squat

3. **Seated Knee extension:** Subject was asked to sit in a stool with both knee flexed & actively extend the knee slowly. (Fig. 4)



Fig. 4: Seated Knee Extension

4. **Leg calf raise:** Subject was asked to stand with the balls of your feet on the step feet about width apart & rise their toe up slowly and return to starting position. (Fig. 5)



Fig. 5: Left Calf Raise

5. **Prone lying knee flexion:** Subject was asked to come in on hand and knee (palm may be open and flat) instructed them to perform Anterior pelvic tilt & ask them to perform knee flexion slowly and then return to starting position. (Fig. 6)



Fig. 6: Prone Lying knee Flexion

## STATISTICS ANALYSIS

In this study the outcome values were obtained by using [www.socscistatistics.com](http://www.socscistatistics.com). The pre-test and post-test interventional differences within the two groups and between the two groups were analysed using paired "t" test and unpaired "t" test for outcome measures. Statistical significance was set at  $p < 0.05$  was considered as a significance difference.

## WITHIN GROUP ANALYSIS FOR EXPERIMENTAL GROUP

The pre & post difference of VJT within the

group analysis of mean & SD were analysed statistically tested by paired t test. The result is presents in the below table.

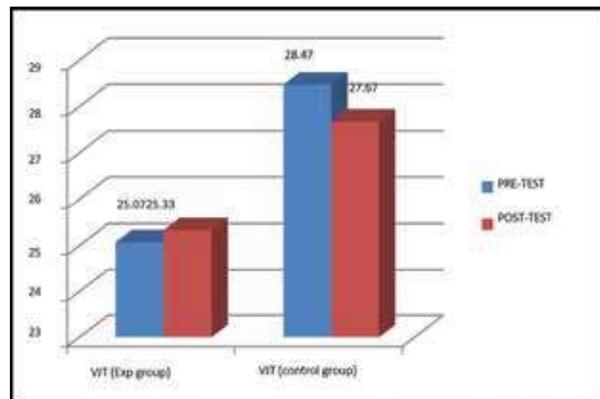
**Table 1:** Within the Group Analysis of VJT for Experimental Group

Outcome	Groups	Mean	SD	't'-value	'p'-value
Vertical Jump Test	Pre-Test	25.07	2.76	10.6014	<0.0001
	Post-Test	28.47	3.54		

**Table 2:** Within the Group Analysis of VJT for Control Group

Outcome	Groups	Mean	SD	't'-value	'p'-value
Vertical Jump Test	Pre-Test	25.33	2.35	12.4864	<0.0001
	Post-Test	27.67	2.50		

The t-Value of VJT for experimental group is 10.6014 & Control group is 12.4864 and with 14 degree of freedom. The p-Value of Experimental & control for VJT is <0.0001\*\*\* Extreme significant



**Graph 1:** Within the Group Analysis of VJT for Experimental & Control Group:

### WITHIN GROUP ANALYSIS FOR GROUP B

The pre & post difference of Q-angle within the group analysis of mean & SD were analysed statistically tested by paired t test. The result is presents in the below table

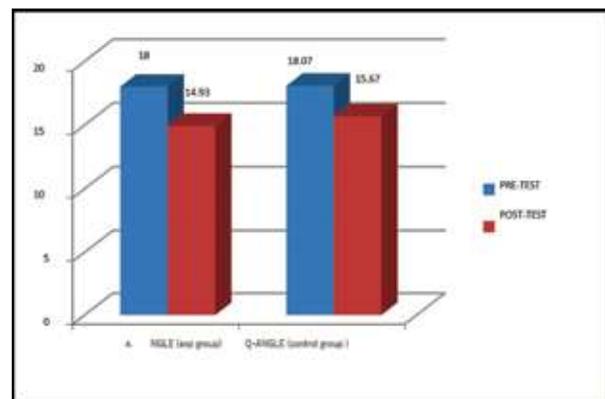
**Table 3:** Within the Group Analysis of Q-Angle for Experimental Group

Outcome	Groups	Mean	SD	t-value	p-value
Q-Angle	Pre-Test	18.00	2.27	16.8774	<0.0001
	Post-Test	14.93	2.34		

**Table 4:** Within the Group Analysis of Q-Angle for Control Group

Outcome	Groups	Mean	SD	t-value	p-value
Q-Angle	Pre-Test	18.07	2.15	18.3303	<0.0001
	Post-Test	15.67	2.16		

The t-Value of Q-ANGLE (Experimental group) for is 16.8774 & control group is 18.3303 and with 14 degree of freedom. The p-Value of experimental & control for Q-angle is <0.0001\*\*\* Extreme significant



**Graph 2:** Within the Group Analysis of Q-Angle for Experimental & Control Group

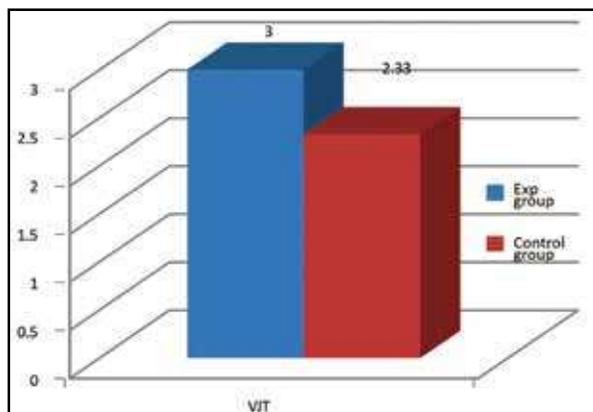
### Between Group Analysis for Experimental & Control Group:

The pre & post difference of VJT & Q-ANGLE Between the group analysis of mean & SD were analysed statistically tested by unpaired t test. The result is presents in the below table statistically tested by paired t test. The result is presents in the below table.

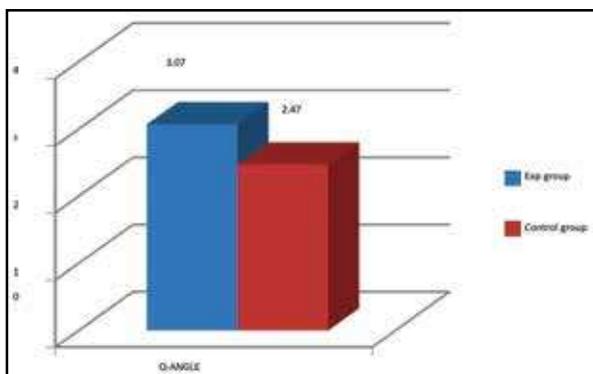
**Table 5:** Between the Group Analysis for Experimental & Control Group

Outcome tool	Exp Group			Control Group			Unpaired 'T' Test	
	Mean	Standard deviation (SD)	Sample size	Mean	Standard deviation (SD)	Sample size	't' value	'p' value
VJT (Vertical jump test)	3.00	0.93	15	2.33	0.72	15	2.1972	0.0127
Q-angle	3.07	0.70	15	2.47	0.52	15	2.6622	0.0153

The 't' value of VJT & Q-angle between the Experimental & control group is 2.1972 & 2.6622 the 'p' value for VJT is 0.0127 & Q-angle is 0.0153 \*statically significant.



**Graph 3:** Between the Group analysis for Exp & for Exp & Control Group (VJT)



**Graph 4:** Between the Group analysis for Exp & Between the Group analysis for Exp & Control Group Control Group (Q-ANGLE)

## RESULTS

### Within the Group Analysis:

**VJT: Experimental Group:** The Mean and SD of VJT for Pre & Post-test values are  $25.07 \pm 2.76$  and  $28.47 \pm 3.54$  and 't' value is 10.6014. The Statistical analysis was done with paired 't' test within the group and shows an extreme statistical significance of ( $p < 0.0001$ ).

**Control Group:** The Mean and SD of VJT for Pre & Post-test values are  $25.33 \pm 2.35$  and  $27.67 \pm 2.50$  and 't' value is 12.4864. The Statistical analysis was done with paired 't' test within the group and shows an extreme statistical significance of ( $p < 0.0001$ ).

**Q-Angle: Experimental Group:** The Mean and SD of Q-ANGLE for Pre & Post-test values are

$18.00 \pm 2.27$  and  $14.93 \pm 2.34$  and 't' value is 16.8774. The Statistical analysis was done with paired 't' test within the experimental group and shows an extreme statistical significance of ( $p < 0.0001$ ).

**Control Group:** The Mean and SD of Q-Angle for Pre & Post-test values are  $18.07 \pm 2.15$  and  $15.67 \pm 2.16$  and 't' value is 18.3303. The Statistical analysis was done with paired 't' test within the experimental group and shows an extreme statistical significance of ( $p < 0.0001$ ).

### BETWEEN THE GROUP ANALYSIS

**VJT:** The Mean and SD of VJT for Pre & Post-test values for Experimental Group are  $3.00 \pm 0.93$  and Control Group are  $2.33 \pm 0.72$  and 't' value is 2.1972. The Statistical analysis was done with paired 't' test within the experimental group and shows an statistical significance of ( $p < 0.05$ ).

**On Analysis:** The Statistical analysis was done using unpaired 't' test between the groups and shows statistical significance ( $p$ -value is 0.0127). Between the group analyses of the mean of the post values shows that the Exp Group is significant than the Control Group. There is more improvement in VJT in Exp group than Control group.

**Q-Angle:** The Mean and SD of Q-ANGLE for Pre & Post-test values for Experimental Group  $3.07 \pm 0.70$  and Control Group  $2.47 \pm 0.52$  and 't' value is 2.6622. The Statistical analysis was done with paired 't' test within the experimental group and shows an statistical significance of ( $p < 0.05$ ).

**On Analysis:** The statistical analysis was done using unpaired 't'-test between the groups and shows statistical significance ( $p$ -value is 0.0153). Between the group analysis of the mean of the post values shows that the Exp. Group is significant than the Control group. There is more improvement in 'Q'-Angle in Exp. group than Group B control-group.

### DISCUSSION

This study is an experimental study and it evaluate the effect of sling open chain knee extension exercise on alteration of 'Q'-angle & improving jumping performance among college Volley ball players. Overall 30 subjects with the age group between 18-26 years of both gender were selected based on inclusion

criteria and they were randomly allocated into 2 groups.<sup>15</sup> subjects within the Experimental (Group A) were treated with SOCKE exercise & Conventional knee exercise.<sup>15</sup> subjects from Control (Group B) were treated with Conventional knee exercise. Both groups were assessed by using the outcome measures like VJT & 'Q' - angle before and after 6 weeks of physiotherapy intervention in Experimental & Control group. After 3 trials of jumping, average score were taken for the investigation of jumping performance.

Ali fatathi *et al.*, (2017) in their study they examine the relationship between 'Q'-Angle & knee injury among Elite Volley ball players. Increase in 'Q' Angle may cause increase in pressure between patella and Lateral femoral condyle during activation of Quadriceps and it is good predictor for knee injury, especially sports with various jumping & landing activities. This study concluded that there is a significant difference between 'Q'-Angle & knee injury among male & female genders.<sup>(13-15)</sup>

Mrityunjay *et al.*, (2014) done a study on comparison between effect of isometric Quadriceps exercise VMO strengthening on Q-Angle & Patella shifting in Q-Angle. This study concluded that VMO strengthening has a great impact on patellar realignment.<sup>(21)</sup>

Wen-dien chang *et al.*, (2014) in their study examine the effect of closed and open kinetic chain on sling exercise therapy on the muscle activity of VMO & VL. Suspension of knee by SET will challenge the trunk core muscle to facilitation in knee extension contraction mechanism & they concluded that SOCKE exercise which easily cause quadriceps muscle contraction and found to be more effective in training the VMO than SOCKE exercise.<sup>(17- 18)</sup> Our results were in agreement with Wen-dien chang *et al.*, (2015) By SOCKE exercise help to increase the VMO muscle contraction and reduce the lateral patellar shift thereby it helps to realignment of patella with normal knee kinematics & improving the jumping performance among volleyball players.<sup>(16)</sup> Mahnoor Asif *et al.*, (2022) in their study concluded that hip strengthening exercise along with knee strengthening were found to be effective in improving the knee pain and it's function among patellofemoral pain syndrome patients therefore in our conventional exercise focus on strengthening both hip and knee musculature and corrects the increased

femoral anti-version reducing the knee load among the volleyball players.<sup>(11)</sup> Therefore our discussion concludes that experimental group shows more significant in 'Q' angle and jumping performance among volleyball players than the control group who receive only conventional knee exercises.

## CONCLUSION

This study concludes that Group-A (Experimental group) who received sling open chain knee extension exercise shows greater statistically significant in reducing Q-angle and improving the jumping performance than Group-B (Conventional knee exercises) by using Vertical jump test and Q-angle measurement among volley ball players for treatment duration of 6 weeks.

## LIMITATIONS & RECOMMENDATIONS

Obese athletes feels difficulty in jumping high, Sample size for this study was small & Follow-up was a short duration (6 weeks). Future recommendations is to conduct more studies with specifically targeting VMO Strengthening in other sport individuals (eg: Basketball players) as well and with varying frequency, intensity & duration of exercises. Large sample is recommended. This study can be conduct in elite volley ball players.

## CONFLICT OF INTEREST & FUNDING

There is no conflicts of interest in this study and there was no funding agencies used in this study.

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