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Comparison between Effect of Isometric Quadriceps Exercise and Vastus Medialis Oblique Strengthening on Quadriceps Angle and Patellar Shift in Normal Individuals

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Abstract:

The knee joint is one of the most important yet complex joints in the human body containing Tibio-Femoral and Patello-femoral joints. The position of the patella is determined by following components – tilt, rotation, shift and Q - angle. To regulate the patellar tracking Vastus Medialis Oblique helps to stabilize the knee cap medially and prevents it from shifting laterally and tracking improperly at the patello-femoral joint and maintains a normal patellar shift and hence a normal Q – Angle. Strengthening of the quadriceps on a whole also help in normalization of patellar shift and Q - angle. This study is aimed to find out that strengthening of which of the above two has a better effect on Q – Angle & Patellar Shift. Thirty normal subjects were randomly divided into two groups. Group A (VMO Strengthening; n = 15), Group B (Isometric Quadriceps Exercise; n = 15). Data Analysis revealed that there was a significant

difference in mean values of Q – Angle & Patellar shift readings after 4 weeks of controlled trials and VMO strengthening had a greater effect on the Q – Angle & Patellar shift than Static Quadriceps exercises. So it can be concluded that the strengthening of Vastus medialis oblique alone is better than isometric quadriceps exercise in reducing the Q – Angle and the lateral patellar shift in normal individuals.

Key words: VMO Strengthening, Static Quadriceps Exercises, Q – Angle, Patellar Shift.

Introduction

The knee joint is one of the most important yet complex joints in the human body. It contains of two joints namely the Tibio-Femoral joint and the Patello-femoral joint. Patella is a triangular bone controlling major portion of mechanics around the knee joint [Helga Deutsch et al, 1978]. Several forces act on the patella to provide stability and keep it tracking properly. These are superiorly directing force by rectus femoris, inferiorly by patellar tendon, medially by VMO and Laterally by Vastus Lateralis [Mark S. Juhn, 1999]. Patella has a tendency to shift laterally as there are lateral forces by structures like ITB, TFL and Vastus Lateralis which is counterbalanced by medially directing force of VMO but it has a tendency to go for weakness [Makhsous M et al, 2004; Lauralyn Reynolds et al, 1983]. The position of the patella is determined by following components – tilt, rotation, shift and Q – angle [Naoko O Aminaka et al, 2005].

Patellar shift is defined as the motion of patella relative to the femur or femoral groove on knee flexion and extension [Marcos V Katchburion et al, 2003]. The patella should be sitting equidistant (±5mm) from each epicondyle when knee is flexed approximately 20°. A 5mm lateral displacement of the patella has been shown to cause a 50% reduce in VMO Tension [D. J. Magee, L.E. Zachazewski, 2001]. The quadriceps (Q)

angle is a clinical measure of the alignment of the quadriceps femoris musculature relative to the underlying skeletal structures of the pelvis, femur, and tibia. It provides a reasonable estimate of the lateral force vector acting on the patella with quadriceps contraction and the tibial-tuberosity position relative to the midline of the trochlea [Lori A. Livingston and Sandi J. Spaulding, 2002]. Normally the angle is 13° in males and 18° for females when measured in supine position. An angle greater than 18° is considered as abnormal [Bhawna Verma, 2007].

The vastus medialis oblique (VMO) muscle has been suggested to act as a dynamic medial stabilizer, which helps to realign the patella during the last 20° to 30° of knee extension. Insufficiency of the VMO, including diminished VMO activity, may increase the lateral pull of the patella and reduce function at the knee joint [Naoko O Aminaka et al, 2005]. That quadriceps weakness, specifically VMO weakness in comparison to the VL, can lead to lateral displacement of the patella causing the articulating pressure to be on the lateral facet. An imbalance in strength can lead to improper patella alignment as a weak VMO cannot adequately support medial patellar stability [Gregory R Waryasz and Ann Y McDermott, 2008]. Quadriceps strengthening is an important technique and is most commonly recommended because quadriceps muscle plays a significant role in patellar movement [Mark S. Juhn, 1999]. It was suggested that isometric exercise would preferably be performed to secure an optimal total strength increase [Lindh, 1979].

Methods:

30 male subjects of SBSPGI with mean age (20.26 ± 1.72) were selected as per inclusion criteria (Age 18 – 24 years, Full range of motion at knee joint, Lateral displacement of patella > 5 mm from center) and exclusion criteria (Pain, Trauma, Quadriceps

tightness, Flat foot, Ligamentuous laxity, Inflamation, Medial patellar shift). At 0 week a proper assessment of the knee joint was performed and Patellar shift and Q – angle were measured Two groups were divided with 15 subjects in each group, namely Group A (mean age 19.86 ± 1.64), Group B (mean age 20.66 ± 1.75). For Group A VMO strengthening was given and for group B Isometric Quadriceps exercise. Exercises were done with 5 repetitions of each for 5 sessions per week in a 4 week protocol[29]. Patellar shift and Q – angle were measured again at 2^{nd} and 4^{th} week followed by Data analysis.

Statistical Analysis:

Independent t-test was done to compare the mean value of Q-angle and patellar shift at 0 week, 2^{nd} week and 4^{th} week between groups A and B to know the extent of improvement. The Significance level (p) was taken as 0.05.

Results:

Unpaired t-test was performed to compare mean values of Q-angle at 2^{nd} week (Q_1) and 4^{th} week (Q_2). Mean values of Group A at 2^{nd} and 4^{th} week were 9.96 ± 1.42, 8.23 ± 1.48 respectively and mean values of Group B at 2^{nd} and 4^{th} week were 10.63 ± 1.32, 9.93 ± 1.48 respectively. The results were non significant at 2^{nd} week, Q_1 ($p > 0.05$) and significant at 4^{th} week, Q_2 ($p < 0.05$). [Refer Table: – 1]

Unpaired t-test was performed to compare mean values of Patellar Shift at 2^{nd} week (PS_1) and 4^{th} week (PS_2). Mean values of Group A at 2^{nd} and 4^{th} week were 0.87 ± 0.13, 0.66 ± 0.14 respectively and mean values of Group B at 2^{nd} and 4^{th} week were 0.94 ± 0.18, 0.78 ± 0.13 respectively. The results were non significant at 2^{nd} week, PS_1 ($p > 0.05$) and significant at 4^{th} week, PS_2 ($p < 0.05$). [Refer: Table – 2]

Discussion:

Comparison of mean values of group A and Group B at 4th week suggest that VMO strengthening has a better effect (than Isometric Quadriceps Exercise) on Q – angle and Patellar Shift Patellar Shift measurement and Q – angle are two important measures for determining normal patellar alignment and mechanics. Supporting the role of Patellar Shift measurement, Sameer Dixit, 2007, stated that Patellar tracking can be altered by imbalances in these stabilizing forces affecting the distribution of forces along the patellofemoral articular surface, the patellar and quadriceps tendons, and the adjacent soft tissues. Hence, measurement of the same can easily suggest the presence of above conditions and the same for the Q – Angle was supported by Lori A. Livingston, 2002, who stated that The quadriceps (Q) angle is a clinical measure of the alignment of the quadriceps femoris musculature relative to the underlying skeletal structures of the pelvis, femur, and tibia. It provides a reasonable estimate of the lateral force vector acting on the patella with quadriceps contraction and the tibial-tuberosity position relative to the midline of the trochlea. Explaining the relation between Q – angle and Patellar Shift Laura H. Lathinghouse, Mark H. Trimble, 2000 and Bhawna Verma, 2007, stated that The greater Q angle creates an excessive lateral force on the patella that may predispose the patella to abnormal patellar tracking.

VMO strengthening has a greater effect as it has a direct relation to the patellar alignment as supported by Naoko Aminaka et al, 2005, who stated that the vastus medialis oblique (VMO) muscle has been suggested to act as a dynamic medial stabilizer, which helps to realign the patella during the last 20° to 30° of knee extension. Insufficiency of the VMO, including diminished VMO activity, may increase the lateral pull of the patella and reduce function at the knee joint. Hence, it can be said VMO is the most important muscle to control the

patellar alignment and its strengthening can very much contribute to the normalization of patellar position.

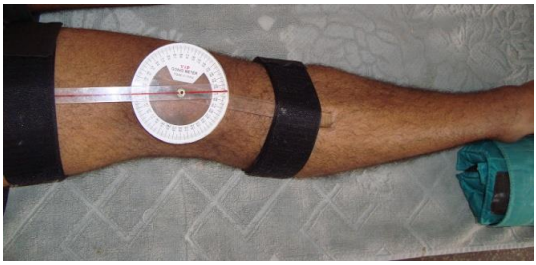
Isometric Quadriceps Exercises prove to be less effective as it works on whole of the quadriceps muscle and not specifically on patellar stabilizers as supported by Mark S. Juhn, 1999, who said Quadriceps strengthening helps in patellar alignment as it creates a balance between all the component muscles controlling the alignment. But, it is doubtful that correct balance will be made if already there is imbalance between VMO and Vastus Lateralis, as mentioned earlier. Moreover isometric exercises are not found to be as efficient as isotonic or isokinetic exercises as seen in the study of Michael J Callaghan et al, 2004, who stated that isometric exercise of quadriceps was just useful to overcome central fatigue and was not as much feasible as Isotonic or isokinetic exercise. Adding to less effectiveness of Isometric Quadriceps Exercise, Lindh M, 1979 stated that Isometric Quadriceps Exercise increases the strength at a slow rate.

Conclusion:

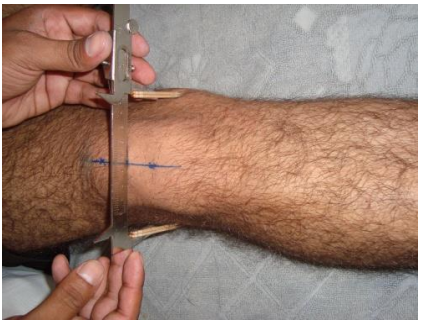
Data analysis says that there is a difference between effect of Vastus medialis oblique strengthening and isometric quadriceps exercise on Q – angle and Patellar Shift, and Vastus medialis oblique strengthening is better than isometric quadriceps exercise in reducing the Q – Angle and the lateral patellar shift in normal individuals.

Images, Graphs & Tables:

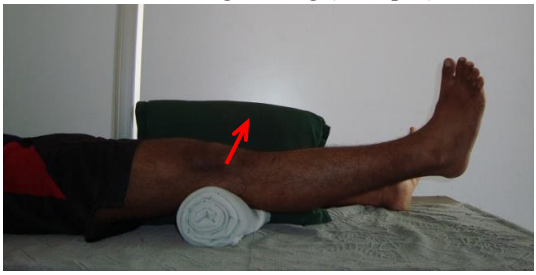
Q – Angle Measurement:



Patellar Shift Measurement:



VMO Strengthening (Group A):



Isometric Quadriceps Exercise (Group B):

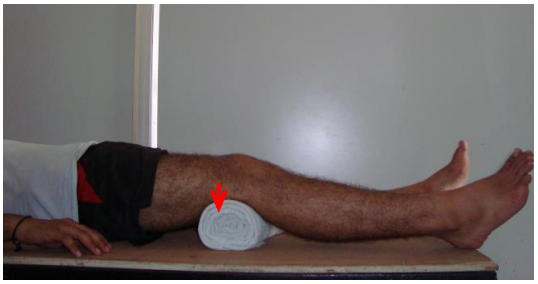


Table 1: Comparison between Q- Angle of Group A and Group B.

Group	Q – angle (2^{nd} week)	Q – angle (4^{th} week)
A	9.96 ± 1.42	8.23 ± 1.48
B	10.63 ± 1.32	9.93 ± 1.48
T - Value	1.36	3.20
significance	N.S	S

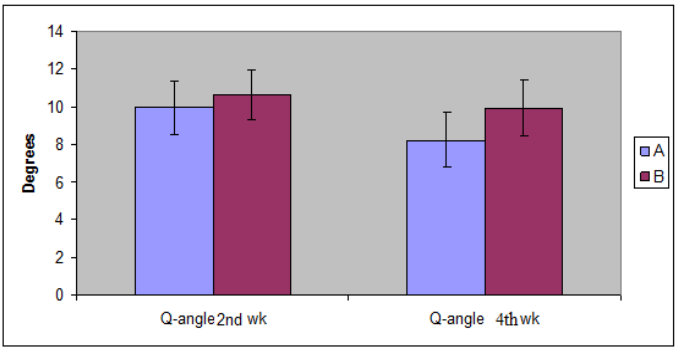
N.S = Non Significant ($p > 0.05$); S = Significant ($p < 0.05$)

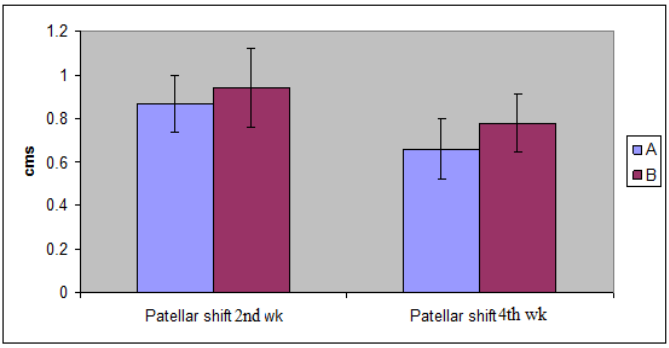
Table 2: Comparison between Patellar Shift of Group A and Group B.

Group	Patellar Shift (2^{nd} week)	Patellar Shift (4^{th} week)
A	0.87 ± 0.13	0.663 ± 0.14
B	0.94 ± 0.18	0.78 ± 0.13
T - Value	1.2	2.35
significance	N.S	S

N.S = Non Significant ($p > 0.05$); S = Significant ($p < 0.05$)

Graphs





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