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# Comparison of the Effects of Core Stability and Balance Exercise on Static and Dynamic Balance and Q-angle of the Students with Genu Varum

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## Abstract

***Background:*** *Genu Varum is one of the most widespread lower limb abnormalities in male young adults. Therefore, this study aimed to compare the effects of balance exercises and core stability exercises on static balance, dynamic balance, rang of motion, muscular endurance and Q-angle in students with Genu Varum.*
***Methods:*** *The statistical population of the study consisted of forty-five 15 to 18-year-old high school students from Mashhad with Genu Varum who divided into three homogeneity groups. At first, pre-test, McGill protocol, Y-test in three directions, tandem test, star test and parenthesis score evaluated. Then, a group of core stability exercises, received Nissari and Qasemi standard protocols (1393), and one group received balance exercises, including the standard protocol of Razavi et al. (1394), and the control group did not exercise any training. Then the post-test done.*
***Results:*** *The findings of the study showed that balance exercises and core stability exercises significantly affect the improvement of static balance, dynamic balance, range of motion, muscular endurance and Q-angle. There is also no difference between the degree of effectiveness of balance exercises and core stability training.*
***Conclusions:*** *Based on the findings, it can be concluded that balancing exercises and core stability can improve the abnormalities of parenthesis and balance knee in students and athletes, and can be used in the physical education curriculum.*

**Keywords:** Genu varum, Balanced exercises, Core stability exercises.
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# Introduction

Lower limbs should be able to distribute bending, torsional, shear, and compressive forces properly. Improper distribution of these forces might cause unnatural movement and, consequently, force extra pressure on podiatric limbs and tissue. This can lead to harm to soft tissues of the body and deficiency of the muscles. One of these popular forms of muscle deformation in young male adults is Genu Varum. Genu Varum is a position of knees that internal condyles of the femur are receded. This form of the knees can cause a change in the natural form of the knee and, consequently, the line of gravity transfers from its natural position to the inner part of the knee, which disturbs the incoming forces on the knee.[1] Studies demonstrate that Genu Varum, on the one hand, destroys articular cartilage in the tibia joint, and on the other hand, prepares the background for the Osteoarthritis.[2] Besides, patellar-thigh pain syndrome and predicting factors in the incidence of knee ligament injuries is another complication caused by parenthesis knee.[2]

Balance is defined as the process of keeping the gravity center of the body within the limits of the reliance level. One of the most important factors in motor preparation is balance, which is divided into two types, that is, static and dynamic. Static balance refers to the ability to keep balance in static and motionless conditions during which one is capable of keeping the gravity center of the body in the limits of reliance level.[3] Dynamic balance includes the capability to keep balance while motioning. Keeping postural stability requires complicated cooperation of sensory, central nervous, and motor systems.[4] In daily life and repairing postural structure also balance and gravity center plays an important role and, therefore, it is essential that, through using these exercises, one takes a step in improving balance, postural structure, and postural abnormalities. Weakness in balance and posture control when confronting factors that disturb it, cause such injuries as pain in the ankle and knee, knee osteoarthritis, and acute ankle aspirins. Keeping balance and motor skills is a complex phenomenon, which describes the body's dynamic posture in preventing fall.[5]

The Center of the body is considered as a muscle box that, helps the stability of the spinal cord, pelvis, and motor chain in functional movements. When this system works properly, it leads to the proper distribution of bending, torsional, shear, and compressive forces in motor chain joints, proper control of the motions, and proper absorption of impact forces brought about by ground reaction forces.[6] For having core stability, it is required to have the harmonious function of the muscles, as the active system, and the joints, bones, and fascia, as the inactive system, and nervous system. These three subsets are interrelated and if each of them causes support to the body, this support is going to affect the whole body and reduce and prevent postural abnormalities.[7]

Several studies approve of the effect of balance exercises on activating the muscles around the knee and improvement of balance performance of the young adults.[2,8,9] Moreover, stability exercises are effective in improving backache, the function of the lumbar-pelvis area, dexterity, the lower limbs' power, and static balance, even balance in different groups.[10-13] Considering the importance of controlling postural abnormalities, especially in younger people, basic students and athletes must be studied so that their postural problems and

abnormalities are corrected and their daily injures be reduced. Therefore, the present study aims at analyzing whether the core stability and balance exercises are effective in improving parenthesis knee complications or not and which of the exercises are more effective in correcting the abnormality.

## Materials and Methods

The current research is semi-experimental and practical, in terms of its nature. The statistical society includes high school students of Mashhad the total number of whom is 12500 people from whom 45 people were chosen as the research sample, through G-power software with the hypothesis that $\alpha \leq 0.05$, which, based on the primary observations, include New York test and Q-angel measure and other medical tests of the students who are diagnosed with Genu Varum and who are at the same condition in terms of height, weight, age, and bodily composition. The students were put into three 15-member groups who were chosen accidentally and categorized based on their level of Genu Varum and were distributed among different groups based on the severity of their Genu Varum condition to make homogenous groups.

To measure the central endurance McGill protocol which includes trunk flexion endurance test, Bearing-Sorenson modified test, bilateral trunk flexion test. Scott status maintenance test was used to evaluate the endurance of lower limbs and, to analyze the dynamic balance of the participants, Y test in three directions (anterior, posterior-internal, and posterior-external) was used. As the pretest, to measure the static balance of the participants, the star test, to measure the dynamic balance of the participants was taken from all three groups and then the distance of the condyles of the hip was measured by Collis. Then, the dynamic exercise group and balance exercise group each did the assigned exercises three days a week for twelve weeks and the control group continued their regular exercise. The selected exercises include five crunches, twist sit-ups, side-lying bridge, prone bridge, and four stages of strengthening exercises of the lower abdominal area. The details of the plan for 6-week core stability exercises done by the participants in the control group are presented in the following table 1.

The exercise protocol of the group of core stability exercises includes the standard protocol of Homaye Razavi et al (2020) that is presented ed in table 2.[14] These exercises are also performed in 6 weeks, three 30 to 40-minute sessions every week. Every session included the following steps:

The exercises started with ten-minute stretching exercises, walking, jogging, and balance exercise protocols, and finally cooling exercises were performed for 10 minutes.

Kolmogorov-Smirnov test was used to analyze the natural distribution, if it was natural; ANOVA, independent and dependent T-tests were performed to analyze data.

**Table 1. The details of the 6-week core stability exercises**

| The first week | Repetition | The fourth week | Repetition |
|---|---|---|---|
| First level LAS | 2 sets and 10 reps in each set | LAS third level | 3 sets and 10 reps in each set |
| Crunch | 2 sets and 10 reps in each set | Crunch | 3 sets and 15 reps in each set |
| Side-lying bridge | 2 sets and 10 reps in each set | Side-lying bridge | 3 sets and 15 reps in each set |
| Twist sit-up | 2 sets and 10 reps in each set | Twist sit-up | 3 sets and 15 reps in each set |
| | | Prone bridge | 2 ten-second sets |
| The second week | Repetition | The fifth week | Repetition |
| First level LAS | 3 sets and 10 reps in each set | Third level LAS | 2 sets and 10 reps in each set |
| Crunch | 3 sets and 10 reps in each set | Crunch | 2 sets and 20 reps in each set |
| Side-lying bridge | 3 sets and 10 reps in each set | Side-lying bridge | 2 sets and 20 reps in each set |
| Twist sit-up | 3 sets and 10 reps in each set | Twist sit-up | 2 sets and 20 reps in each set |
| | | Prone bridge | 3 10-second sets |
| The third week | Repetition | The sixth week | Repetition |
| Second level LAS | 2 sets and 10 reps in each set | Fourth level LAS | 3 sets and 10 reps in each set |
| Crunch | 2 sets and 15 reps in each set | Crunch | 3 sets and 20 reps in each set |
| Side-lying bridge | 2 sets and 15 reps in each set | Side-lying bridge | 3 sets and 20 reps in each set |
| Twist sit-up | 2 sets and 15 reps in each set | Twist sit-up | 3 sets and 20 reps in each set |
| | | Prone bridge | 2 15-second sets |

**Table 2. Balance exercise protocol**

| | First week | Second wee | Third wee | Fourth wee | Fifth week | Sixth week |
|---|---|---|---|---|---|---|
| First session | 1st to 6th move 6*3 | 1st to 6th mc 10*3 | 1st to 6th mc 15*3 | Circular exerc Every 6 mo Every mov 15 reps | Circular exercis Every 6 move Every move 20 reps | Circular exercise Every 6 move Every move 25 reps |
| Second session | 1st to 6th move 6*3 | 1st to 6th mc 10*3 | 1st to 6th mc 15*3 | Circular exer Every 6 mo Every mov 15 reps | Circular exercis Every 6 move Every move 20 reps | Circular exercis Every 6 move Every move 25 reps |
| Third session | 1st to 6th move 6*3 | 1st to 6th mc 10*3 | 1st to 6th mc 3*15 | Circular exer Every 6 mo Every mov 15 reps | Circular exercis Every 6 move Every move 20 reps | Circular exercis Every 6 move Every move 25 reps |

1. Ront scale on either leg with support
2. Standing on one foot with a bent knee and crossing hands on the chest
3. Front scale on either leg without support
4. Keeping a balance on a balance board with open eyes and standing on one foot
5. Anterior-posterior and keeping balance on a balance board with open eyes
6. Standing on one foot in the interior-exterior direction

**Table 3. Average age, height, weight, BMI, and G-angel**

| Group | Numbers (people) | Mean±SD | | | | |
|---|---|---|---|---|---|---|
| | | Age (year) | Height (cm) | Weight (kg) | BMI | Q-angel |
| Balance | 15 | 1.24±15.22 | 168.21±3.15 | 65.25±4.21 | 23.12±2.21 | 5.88±0.05 |
| Core stability | 15 | 3.18±16.23 | 171.24±2.16 | 66.45±4.16 | 24.51±1.54 | 5.95±0.04 |
| Control | 15 | 3.15±15.81 | 169.35±5.41 | 68.41±4.13 | 23.54±2.14 | 5.94±0.06 |
| Comparing the groups by ANOVA | - | 0.145 | 0.245 | 0.263 | 0.188 | 0.188 |

**Table 4. The results of the inter-group and intra-group changes in core stability exercise group independent variables**

| Variable | Mean | | Groups | Inter-group Pvalue | Intragroup Pvalue | |
|---|---|---|---|---|---|---|
| | Pretest | Posttest | | | Pretest | Difference in scores |
| Q-angel | 5.88±0.05 | 7.69±0.214 | Balance exercise | 0.000 | 0.099 | 0.000 |
| | 5.94±0.06 | 5.32±0.148 | Control | 0.124 | | |
| Static balance | 15.24±0.117 | 18.95±0.142 | Balance exercise | 0.000 | 0.106 | 0.000 |
| | 15.11±0.295 | 15.12±0.174 | Control | 0.000 | | |
| Dynamic balance | 1.64±0.666 | 2.98±0.412 | Balance exercise | 0.000 | 0.216 | 0.000 |
| | 1.88±0.65 | 1.88±0.25 | Control | 0.166 | | |
| Range of movement | 5.65±0.541 | 0.214 ±8.14 | Balance exercise | 0.000 | 0.182 | 0.001 |
| | 5.41±0.274 | 0.185 ±5.39 | Control | 0.214 | | |
| Muscular endurance | 34.52±0.514 | 45.21±0.321 | Balance exercise | 0.000 | 0.162 | 0.000 |
| | 38.54±0.237 | 38.01±0.45 | Control | 0.254 | | |

**Table 5. The results of inter-group and intra-group changes in core balance exercise independent variables**

| Variable | Mean | | Groups | Inter-group Pvalue | Intra-group Pvalue | |
|---|---|---|---|---|---|---|
| | Pretest | Posttest | | | Pretest | Difference in scores |
| Q-angel | 5.94±0.254 | 7.89±0.614 | Core balance exercise | 0.000 | 0.113 | 0.000 |
| | 5.35±0.135 | 5.32±0.148 | Control | 0.265 | | |
| Static balance | 15.45±0.254 | 19.09±0.241 | Core balance exercise | 0.000 | 0.214 | 0.000 |
| | 15.11±0.295 | 15.12±0.174 | Control | 0.618 | | |
| Dynamic balance | 1.76±0.89 | 3.21±0.028 | Core balance exercise | 0.000 | 0.635 | 0.000 |
| | 1.88±0.65 | 1.88±0.25 | Control | 0.116 | | |
| Range of movement | 5.02±0.239 | 7.88±0.284 | Core balance exercise | 0.000 | 0.239 | 0.000 |
| | 5.41±0.274 | 0.185 ±5.39 | Control | 0.261 | | |
| Muscular endurance | 29.41±0.87 | 45.20±0.315 | Core balance exercise | 0.000 | 0.116 | 0.000 |
| | 38.54±0.237 | 38.01±0.45 | Control | 0.168 | | |

**Table 6. Comparison between the effect of balance exercise and core stability exercises on dependent research variables**

| | Standard deviation | Standard deviation | Average error | Lower bound | Upper bound | T statistics | Pvalue |
|---|---|---|---|---|---|---|---|
| Correcting Q-angel | -2.41 | 0.254 | 0.188 | 1.241 | 0.245 | 7.354 | 0.124 |
| Static balance | -0.789 | 0.524 | 0.099 | 1.24 | 0.410 | 8.254 | 0.125 |
| Dynamic balance | -0.106 | 0.560 | 0.161 | 0.810 | 0.241 | 4.254 | 0.087 |
| Range of movement | -0.142 | 0.264 | 0.345 | 0.545 | 0.36 | 0.415 | 0.162 |
| Range of movement | -0.145 | 0.325 | 0.364 | 0.879 | 1.254 | 6.541 | 0.415 |

## Results

Demographic characteristics of the participants presented in table 3.

Based on the results of table 3, one can observe that research groups were almost homogenous and there is no difference between the research groups in terms of demographic features.

The results of the ANOVA test between the mean difference of the pretest and post-test in the control and balance exercise group is observed whit the core stability exercise group, is presented in tale 4. based on the results the difference is significant in such variables as muscular endurance, range of movement, static balance, dynamic balance, and Q-angel. (Table 4).

Based on the results of the test T independent between the mean difference of the pretest and posttest in the control and exercise group is observed which in the balance exercise group, the difference is significant in such variables as muscular endurance, range of movement, static balance, dynamic balance, and Q-angel. (table 5).

Based on table 6, in the results of the balance exercise group and core stability exercise group, there is no significant difference in improving muscular endurance, range of movement, static balance, dynamic balance, and Q-angel. ($0.05 \leq \alpha$).

## Discussion

The purpose of this study was to investigate the effect of balance exercises and core stability exercises on static balance, dynamic balance, range of motion, muscular endurance, and Q-

angle in male students with Genu Varum. The findings of the study showed that both balance exercises and core stability exercises significantly affect the improvement of Genu Varum and correcting Q-angel and there is also no difference between the degree of effectiveness of the two training protocols and both exercises equally affect the improvement of Genu Varum. In other words, one can say that balance exercises and core stability exercises are among the methods, which can be used to improve Genu Varum in people, especially young men. Mechanical Genu Varum is caused by muscular weakness in external knee muscles and decreases in the length of internal knee muscles, which in both training protocols, through strengthening muscles and improving their flexibility, a correction of Q-angel and improvement of Genu Varum was observed. In other words, through presenting a proper protocol with balance exercises or exercises that strengthen the body muscles, one can improve this deficiency in young adults; the effectiveness of these protocols does not show any significant difference with each other. Both in balance exercises and core stability exercises, the abnormalities caused by Genu Varum are decreased through strengthening the posture control system in the body and the decrease in balance which is caused by Genu Varum is corrected through these exercise protocols. These results go along with the findings of Mousavi et al (2016) and Ebrahimi et al (2015) in which the effect of these exercises on the improvement of Genu Varum and ligaments, and knee ligaments affirmed.[2,9] The results of the study also indicate that balancing exercises and core stability exercises can improve the range of movement in male students and there is no significant difference in the effectiveness of these two exercises. The therapeutic exercises which were given based on balancing exercises and core stability training were presented through standard protocols and included such exercises the aim of which was to improve the bodily posture and strength and endurance of the muscles as a result of which an improvement in the range of movement in knee joints was observed. Upon the improvement in Genu Varum, the range of movement increases and one can gain a higher ability in moving their joints. The increase in the flexibility of the muscles and improvement in Genu Varum were among the purposes of the study and upon the increase in the male participants' flexibility, their range of movement also increased. These findings go with the findings of other researches.[2,8,9,11]

The research findings also show the improvement in the dynamic and static balance due to balance exercises and core stability exercises. Similarly, no difference was observed between the balancing exercise and core stability exercise groups in this variable either and both training protocols were equally effective in the male student participants in terms of their improvement of dynamic and static balance that shows the positive effects of both training methods. Core stability exercise is for the effective biomechanical function of the limbs that work, through increasing power production and decreasing muscle burdens in all kinds of activities, from running to throwing. It is not known which anatomic and physiologic factors can be effective in producing core stability, so that is why the physical evaluations of core stability are also of various kinds. Based on closed movement chain theory, the power of thigh muscles is vital for the control of lower segments and prevention of injury; and if one of the lower limb joints does not function well, then the rest of the joints will be affected. For keeping balance in a static position or during activities, one needs to produce enough power in muscles which requires a complicated connection in the musculoskeletal system. The most probable reasons for increasing height control, after balance exercises and core balance exercises, can be the change in the mechanoreceptors feedback which leads to reorganization of the central nervous system and sensory-motor integrity and finally leads to a change in motor response. Besides, one can also mention activation of deep sensory receptors, preparation of motor neurons in some muscles and joints for doing the moves, increase in integrity and harmony of the motor units, contraction of fellow muscles, and increase in dispassion in antagonistic muscles.[15,8,9,11,13] Also emphasized the positive effect of balance exercises and core stability exercises in the athletes' and non-athletes balance. But Mahieu et al (2016) pointed to the ineffectiveness of these exercises on skiers' balance which is due to the high balance of these athletes and one cannot make an eye-catching change in these athletes merely through a-couple-of-week training protocols.[16] The findings also show that muscular endurance also significantly increases under the influence of balance exercises and core stability exercises and in this variable also, no significant difference was observed. Balance exercises and core stability exercises were effective in improving muscular strength and endurance due to creating deep sensory and muscular contractions and after the implementation of training protocols, a significant increase in the strength of the lower limbs was observed. Balance is influenced by effective function and strength and endurance of the muscles and the presented exercises, due to causing an increase in muscular contraction, can lead to an improvement in strength, endurance and, consequently, an improvement in the balance of the male students; these findings are aligned with the findings of others.[9,8]

Since the balance exercises and core stability exercises have an equally significant effect on the improvement of Genu Varum, balance, muscular endurance, and range of movement, it is recommended to be used by the trainers in schools so that it reduces postural abnormalities in students. It is also recommended that these exercises be taught in coach-training sessions so that the trainers could use them to correct postural abnormalities and improve balance in athletes.

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## Conflict of Interest

The authors declare that they have no conflict of interest.

## References

1. Blackburn T, Guskewicz KM, Petschaur MA, Preritice WE. Balance and joint stability. The relative contributions of proprioception and muscular strength J sport Rehabil 2016;9:315-28. doi:10.1123/JSR.9.4.315

2. Mousavi S, Hashemi Taklimi M, Barati A, Ghasemnian A. Knee joint muscles activity during single leg drop landing from different heights among men with genu varum and men with normal knee. J Gorgan Univ Med Sci 2016;18:71-8

3. Kaesler DS, Mellifont RB, Kelly PS, Taaffe DR. A novel balance exercise program for postural stability in older adults. Journal of Body work and Movement Therapies 2011;11:37-43. doi:10.1016/j.jbmt.2006.05.00358

4. Daneshmandi H, Gharakhanloo R, Alizadeh MH. Sport Pathology. SAMT publications, Tehran, 2007 [Persian].

5. Wilkerson GB, Colston MA, Short NI, Neal KL, Hoewischer PE, Pixley JJ. Neuromuscular changes in female collegiate athletes resulting from a plyometric jump-training program. Journal of Athletic Training 2004;39:17.

6. Marsh De, Richard La, Williams LA, linch Kj. The relationship between balance and pitching in college baseball pitchers. J Strength Con Res 2016;18:441-56

7. Gribble P, Hertel J, Denegar C, Buckley W. The effects of fatigue and chronic ankle instability on dynamic postural control. J Athl Train 2014;39:321-9.

8. Ghaderi A. Analyzing the effect of active stability spinal exercises on the back function in Sagittal plane of healthy people. MS Thesis 2016 Tehran University. Tehran.

9. Ebrahimi M. Analyzing the effect of balance exercises on balance tests and dynamic stability limits in healthy men through using biodex, MS thesis 2015. [Persian].

10. Hodges P, Kaigle HA, Holm S, Ekström L, Cresswell A, Hansson T, et al. Intervertebral stiffness of the spine is increased by eroked contraction of tranversus abdominis and the diaphragm: in vivo porcine studies. Spine (Phila Pa 1976) 2017;28:2594-601. doi:10.1097/01.BRS.0000096676.14323.25

11. Mayels G, Colston M. Short N, Paul E. Pixley J. Neuromuscular changes in female Volleyball and Basketball Athletes Resulting from a plyometric jump-training and strength and power. J Athl Train 2015;*42:186-92.*

12. Samson, A. Balance abilities of Tennis Players in amateur level. J Sports Sci & Med 2015;4:7-14.

13. Kultimers S, Lephart SM, Sterner R, Kuligowski L. Balance training for persons with functionally unstable ankles. J Orthop and Sport Phys Ther 2010;29:478-86. doi:10.2519/jospt.1999.29.8.478

14. Homaye Razavi SS, Shojaedin SS, Karimi Z, Barzeh S. Effect of six weeks of neuromuscular and performance balance training on balance and performance lower extremity climber girls. PTJ 2020;10:213-20

15. Granacher U, Albert G, Susi Kriemler Research. Effects of Balance Training on Postural Sway, Leg Extensor Strength, and jumping Height in Adolescents. Research Quarterly for Exercise and Sport 2010;18:245-51.81. doi:10.1080/02701367.2010.10599672

16. Mahieu E, Nele N, Witvrouw D, Van DV, Diny M, Vale´ rie A. Improving strength and postural control in young skiers: Whole-body vibration versus equivalent resistance training. J Athletic Trai 2016;41:286-93.