Correlation Between Tibiofemoral Angle And Sacral Angle In Female With Bilateral Genu Valgum

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Abstract

Background: Genu Valgum is adeformity in which the axial alignment of the lower limb is disturbed with exaggeration of the tibio-femoral angle. Such deformities resolve by themselves during infancy and childhood, but if they persist in adolescent age, there is no chance of resolution and might pose serious problems for the individual in the future. The aim of this study was to determine correlation between tibio femoral angle and sacral angle in female with bilateral genu valgum. **Methods:** Sixty-four female students with bilateral genu valgum participated in the study. They recruited from Deraya University. Their age ranged from 18 to 25 years old,Q angle >20 and BMI≥ 30 (kg/m^2).X-ray of the lower limbs used for measurement of tibio-femoral angle; in addition, X-ray of lumbosacral spine used for measurement of sacral angle. **Results:** However, there was a statistical significant correlation between left tibio-femoral angle and sacral angle (r= -0.3098; p= 0.0126),there was no statistical significant correlation between right tibiofemoral angle and sacral angle (r= -0.1945; p= 0.124).**Conclusion:** According to results of the study, there was association between left tibio-femoral angle and sacral angle but there was not association between right tibio- femoral angleand sacral angle

Keywords: Genu valgum, tibio femoral angle, sacral angle

Introduction:

Genu Valgus is a deformity in which the axial alignment of the lower limb is disturbed and an exaggeration of the tibio femoral angle (formed by the intersection of mechanical axis of femur with mechanical axis of tibia) occurs[1].The prevalence of genu valgus in Soouzest Brazil estimated to be 7.1 % in 2015.The frequency was higher among overweight or obese schoolchildren[2].

The knee has been optimally adapted to the forces and loads acting at and through the knee joint. However, anatomy of the knee joint is variable and the only constant is its complex function, which is the result of an optimal interplay of bony structures such as femur, tibia, patella and fibula as well as its ligaments, tendons, muscles and joint capsule[3].

Genu varum and medial tibial torsion are normal in newborn and infants and maximal varus is present at 6 to 12 months of age. With normal growth, the lower limbs gradually straighten with a zero tibio-femoral angle by 18 to 24 months of age (when the infant begins to stand and walk). With further normal development, knees gradually drift into valgus. This valgus deformity is maximal at around age 3–4 years with an average lateral tibio-femoral angle of 12 degrees. Genu valgum spontaneously correct by the age of 7 years to that of the adult alignment of the lower limbs of 8 degrees of valgus in the female and 7 degrees in the male. The greater degree of valgus in females may be due to their wider pelvis[4].

Genu valgum induces femoral ante-version, tibial lateral torsion, increased Q-angle, patellar lateral dislocation, toe-out, subtalar pronation, and so on[5]. Several past studies have reported that the loss of alignment in a part of the body for a longer duration causes lengthened or shortened muscles, some researchers believe that abnormal alignment may be even caused by muscle imbalance or change in ligament complex, articular capsule or musculo tendinous structures[6].

knock-knee is accompanied by decreased physical activity in relation to the severity of the valgus angle, some children may optimize bone health during a later period in life when they assume childrenare more active[7].Thereis also apositive correlation between incidenceof genu valgum and overweight/ obese children, thus leading to reduced physical activity levels[8]. Children with this condition are predisposed to degenerative changes in the knee and hip in later life[9].

There is a closed kinetic relationship between the human knee and low back spine so that any dysfunction of this may result in trick motion and compensation, joint dysfunction and eventually pain in one or both countries. Thus, LBP could cause increased knee pain due to biomechanical interrelationship of knee joints and low back spine joints in the kinetic chain[10].

Malalignment is mainly measured by means of the hip–knee–ankle (HKA) angle on full-limb X-ray, assessing the mechanical axis in the knee. Full-limb radiographs are used specifically to determine the HKA angle in most cases to surgically adjust this angle[11].

Although knee pain and LBP are common conditions, but only a few researches have investigated biomechanical relations or coexistence of these two common conditions. Knee dysfunction and pain may result in walking difficulties and more stress on other joints of lower limbs and low back spine. In recent years, physical deconditioning has been regarded as one of the perpetuating factors for chronicity in theoretical research models on pain. Thus, physical deconditioning can cause both low back and knee pain simultaneously[12]. Therefore, this study conducted to determine correlation between tibiofemoral angle and sacral angle in female with bilateral genu valgum .

Methods

Study design:Correlational study, with a sample of sixty-four female with bilateral genu valgum,***Participants:***aged from 18-25 years old and BMI≥ 30(kg/m^2). They recruited from Deraya University and Informed consent taken from all the patients included in the study. The study approved from ethical committee of Faculty of Physical Therapy, Cairo University (P.T.REC/012/002045). Purposes of the study, methodology and experiments protocol were explained to every patient participated in the study.The practical part continued from October 2018 to January 2019.Patients that had undergone previous surgery, associated lumbar spine fracture, spondylolisthesis, foramina or extra foramina disc herniation, spine tumors, infection, bone metabolic diseases and any surgery related to knee excluded from the study.

Procedure of the Study:

Measurement procedure:

First, interview was arranged for female students with age range from 18-25years old

2- Anthropometric data concerning height and weight was measure, then BMI was calculate according to the following equation; BMI (weight ([kg])/height square ([m^2]).

3-Students with BMI≥ 30 (kg/m^2) was continue with our study.

4- Selected students was screen for genu valgum via postural assessment from frontal view then measuring the Q angle bilaterally as follow:

1-With the subject in supine lying position and exposing both lower limbs, feet together, thigh muscles relaxed and ankles in neutral position.

2-The center of patella, tibial tuberosity and anteriorsuperior iliac spine (ASIS) was carefully located by palpation.

3-The meter rule used to draw a straight line from the center of the patella to ASIS, and another line from the tibial tuberosity to the center of patella.

4-The acute angle formed between the two lines measured with the flexiometer and recorded as Q- angle [13]

5-Subjects with Q angle more than 20 degrees [14] was under the following procedures:

A-Full-Length AP standing X-ray:

•Using Fluoroscopy with the posterior part of each femoral condyle being used as Reference.

•A footprint drawn on the floor to be able to reproduce the position of the limb for the final radiograph.

•One standing AP recording with both lower extremities exposed at the same time and with the student standing in a weight-bearing position.

• Knee joints were fully extended, and touching each other. Beam was centered at level of the knees.

. •Images were saved in the picture archiving and communication system [15,16].

•The hip-knee angle was measured (the angle between themechanical axis of the femur and the tibia)[15,17]. It was obtained by connecting the center of the femoral head to the midpoint of the tibial eminential spine in a line tangential to the femoral condyles, and another line from here to the center of the trochlea tali (normal range is 4.43° ± 0.68 for girls at 17 to 18 years of age in south Indian children)[18].

B- Lumbo-sacral X-ray lateral view was done at the time and sacral angle was measure by Ferguson´s technique as follow:

•With a 30 cm long transparent ruler, lines for the measurement of the angle was draw with a pencil, using appropriate Landmarks formed by two lines, the first line was a straight line along the superior margin of the sacrum, and the second line was the horizontal line. Then the acute angle between 2 lines was measured in degrees using a protractor and it was the sacral angle[19].

Statistical analysis:

Numericaldata were explored for normality by checking the distribution of data calculating the mean, standard deviation using the test of normality Kolmogorov-Smirnov and Shapiro-Wilk test. Sacral angle showed nonparametric distribution. To test the association between sacral angle and tibio-femoral anglespearman′s rank correlation was used. Alpha level of significant was set less than 0.05.

Results:

1. **General characteristics of the subjects as shown in table (1):**

Variable	Mean ± SD
Age	19.59±0.987
Height	1.62±0.101
weight	95.44±15.36
Body Mass Index (BMI)	36±4.56

2. **Correlations between tibio-femoral angle and sacral angle:**

Variable	Mean ± SD
Right tibio femoral angle	14.34 ± 1.5
Left tibio femoral angle ,sacral angle	13.16 ± 1.34
Sacral angle	46.19 ± 2.75

3- Correlation between right tibio-femoral angle and sacral angle:

As shown in table (2), there was no statistical significant correlation between right tibio-femoral angle and sacral angle (r= -0.1945; p= 0.124).

- Correlation between left tibio-femoral angle and sacral angle:

As shown in table (2), there was a statistical significant correlation between left tibio-femoral angle and sacral angle (r= -0.3098; p= 0.0126).

Table (5): Correlations between tibio-femoral angle and sacral angle:

	Sacral angle	
	Spearman's rank Correlation	**P value**
Right tibio-femoral angle	-0.1945	0.124 (NS)
Left tibiofemoral angle	-0.3098	0.0126 (S)

NS= p> 0.05= not significant.

Discussion:

This study was carried out to determine correlation between tibio femoral angle and sacral anglein females with bilateral genu valgum in Deraya University.

Findings of the study revealed that there was no statistical significant correlation between right tibio-femoral angle and sacral angle (r= -0.1945; p= 0.124). In addition, there was a statistical significant correlation between left tibio-femoral angle and sacral angle (r= -0.3098; p= 0.0126).

Regarding the statistical significant correlation between left tibio-femoral angle and sacral angle may be attributed to disturbance in normal biomechanics along with muscle imbalance.

Genu valgum induces femoral ante-version, tibial lateral torsion, increased Q-angle, patellar lateral dislocation, toe-out, subtalar pronation[5.] Increased femoral ante-version causes anterior displacement of the femoral head in the acetabulum and a decrease in congruity of the hip joint. Thus, improvement in the congruity of the hip joint may occur with excessive internal rotation of the hip. Excessive internal rotation of the hip leads to knee valgus alignment as a result of a kinematic chain[20].

Experimental evidence suggests that increased femoral ante-version can result in substantial reduction in the abduction moment arm of gluteus medius, which is restored by compensatory increase in internal rotation of hip[21].Morgan and Javidclaimed the primary function of the gluteus maximus muscles is to externally rotate and extend the knee, a weak or inhibited GM can result in internal rotation of the femur, placing the knee into genu valgus[22].

The results of this study come in agreement with a studymentioned that excessive anterior tilting of the pelvis resulting from weakness of the posterior rotators of the pelvis (ie, gluteus maximus, hamstrings, and abdominals) and/or tightness of the hip flexors may result in compensatory lumbar lordosis and a resulting posterior shift in the trunk position. As described earlier, a posterior shift in the center of mass during functional activities would increase the knee flexion moment and the demand on the knee extensors, while simultaneously decreasing the hip flexion moment and the demand on the hip extensors. the compensatory posterior shift of the trunk and center of mass may perpetuate hip extensor weakness and, in turn, result in greater anterior tilting of the pelvis. This chain of events may explain the clinical observations of hip extensor weakness in persons who present with excessive anterior tilt of the pelvis[23].

Imbalanced muscle activity tightness and over activity of the hip flexors and low back extensors and a coexistent under activity in the abdominals and glutei create crossedpattern' of disturbedsagittal lumbopelvicposturo-movement alignment and control[24].

Furthermore, the line of gravity is located frontally along a vertical line passing through the middle of the sacrum and perpendicular to the ground, and laterally through a vertical line situated slightly to the rear of the femoral heads . In healthy asymptomatic subjects, this line of gravity is a result of a reaction between the ground and an ideal dynamic chain between the trunk, pelvis and lower limbs. In most pathological settings, the centre of gravity is too far forward with a mechanical axis located in front of the femoral heads . This type of situation is commonly seen in the event of abdominal hypertrophy, pregnancy, marked thoracic kyphosis (osteoporosis) not compensated by adequate lordosis, and above all, in major degenerative lumbar disc disease in elderly subjects .

Moreover, Lazennec in 2013claimed during the occurrence of lumbar lordosis, it also happens with the sacrum becoming horizontal as a result of the effect of vertical muscles. In case of high pelvic incidences lumbar lordosis expands and femur heads slide forward with reference to the sacrum[3]

References

1-Rahman A, Badahdah A, Msc W: Normal developmentof the tibiofemoral angle in Saudi children from 2to 12 years of age. World Applied Sciences Journal, 2011,12(8);1353-61

2-Ciaccia m, pinto m, golfieri f, machado t, lozano l, silva j, and rullo v: prevalence of genu valgum in public elementary schools in the city of santos (sp), brazil. rev paul pediatr ., 2017, 35(4); 443–447.

3-Hirschmann Michael T , Müller Werner :Complex function of the knee joint: the current understanding of the knee .Knee Surgery, Sports Traumatology, Arthroscopy, 2015,23(10); 2780–2788

4-Espandar R, Mortazavi SM, Baghdadi T:Angular deformities of the lower limb in children. Asian J Sports Med., 2010,1(1);46-53

5-Park Seol, Ko Yu-Min, Jang Gwon-Uk and Park Ji-Won :A Study on the Differences of Quadriceps Femoris Activities by Knee Alignment during Isometric Contraction. Journal of Physical Therapy Science,2014, 26 (11) ;1685–1688

6-Tella BA, Akinpelu AO, Omololu AB: Normal values of tibio-femoral angle in Nigerian adoloscents. Internet J Orthop Surg .,2009,17;3171.

7-Kaspiris, A., Zaphiropoulou, C., and Vasiliadis, E.: Range of variation of genu valgum and association with anthropometric characteristics and physical activity. Journal of Pediatric Orthopedics B, 2013, 22(4); 296–305

8-Khalid Zara, Rai Mishal Ali , Mobeen Bushra and Amjad Imran: Pes planus& genu valgum, factors associated. Professional Med J., 2015, 22(10);1237-1244.

9-Carreiro Jane E (2009): Chapter Five - Femur, hip and pelvis. Pediatric Manual Medicine, An Osteopathic Approach,2009 ;193-272

10-Suri P, Morgenroth DC, Kwoh CK, Bean JF, Kalichman L and Hunter DJ: Low back pain and other musculoskeletal pain comorbidities in individuals with symptomatic osteoarthritis of the knee, data from the osteoarthritis initiative. Arthritis Care Res., 2010, 62;1715-23

11-G. M. Brouwer, A. W. Van Tol , A. P. Bergink , J. N. Belo, R. M. D. Bernsen M. Reijman, H. A. P. Pols, S. M. A. Bierma- Zeinstra:Association between valgus and varus alignment and the development and progression of radiographic osteoarthritis of the knee.Arthritis & Rheumatism,2007, 56, 4

12-Rahbar Mohammad, Shimia Mohammad, Toopchizadeh Vahideh and Abed Masud: Association between knee pain and low back pain. J Pak Med Assoc.,2015, 65(6);626-31.

13- Oladapo M, Olagbegi Abideen A, Akinloye Olutola O, Olufiade Joseph A, Jegede Morohunkola O and Ojeyinka : Quadriceps angle and its relation with hip rotation measured in two starting positions.2018

14- Omololu BB, Ogunlade OS, Gopaldasani VK: Normal Q-angle in an adult Nigerian population. Clin Orthop Relat Res.,2009, 467(8)

15-Paley D, ed: Principles of deformity correction. 1st ed. Springer-Verlag Berlin Heidelberg, 2002; 1-18.

16-Sanfridsson J, Ryd L, Svahn G et al: Radiographic measurement of femora tibial rotation in weight-bearing, The influence of flexion and extension in the knee on the extensor mechanism and angles of the lower extremity in a healthy population. Acta Radiol,2001,42;207-17.

17-Sabharwal S and Zhao C: The hip-knee-ankle angle in children, reference values based on a full-length standing radiograph.J Bone Joint Surg Am,2009

18-Mathew SE and Madhuri V: Clinical tibiofemoral angle in south Indian children Bone Joint Res., 2013, 2; 155-161.

19-OkpalaFO: Measurement of Lumbosacral Angle in Normal Radiographs: A Retrospective Study in Southeast Nigeria. Ann Med Health Sci Res.,2014, 4(5); 757–762.

20-Kaneko M and Sakuraba K: Association between Femoral Anteversion and Lower Extremity Posture upon Single-leg Landing, Implications for Anterior Cruciate Ligament Injury. J Phys Ther Sci.,2013, 25(10);1213-7.

21-Zaflropoulosa George, Prasada Kodali Siva R.K., Koubourab Thomai, Danisb George: Flat foot and femoral anteversion in children-A prospective.2009

22-MorganWilliamEand JavidAmin: The Gluteal-Knee Connection. Dynamic Chiropractic,2014; 32(15).

23-Christopher Powers: The influence of abnormal hip mechanics on knee injury, a biomechanical perspective. J Orthop Sports Phys Ther.,2010,40 ; 42-51

24-Josephine Key:The Pelvic Crossed Syndromes: A reflection ofimbalanced function in the myofascial envelope;a further exploration of Janda’s work.Journal of Bodywork & Movement Therapies, 2010, 14, 299-301