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The Biomechanical and Functional Status of Patients with Knee Osteoarthritis - A Cross Sectional Study

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Abstract

Background and Objectives: Knee deformity associated with osteoarthritis (OA) is one of the most common complications reported to orthopaedic surgeons. *Genu valgum* and *genu varum* are the most commonly occurring deformities due to knee osteoarthritis. When there is progression in degeneration due to osteoarthritis, deformities tend to worsen and will eventually lead to reduction in cadence rate, hindfoot angle, range of motion in both hip and knee. Thus, this study is conducted to analyze these parameters like cadence, hindfoot angle, hip internal flexion, knee flexion, WOMAC scale and VAS pain rating scale between the groups of individuals with *Genu valgum* and *genu varum* deformity.

Methodology: A convenient division was made of a total of 80 knee osteoarthritis (OA) patients into two groups by measuring their medial tibiofemoral angle, namely *Genu valgum* and genu varum. The patients were evaluated for various parameters including gait cadence, reduced knee flexion, hip internal rotation, hind foot angle, WOMAC scale, and VAS pain scale. The discrepancies in these parameters were analyzed between the *Genu valgum* and *genu varum* groups. This study design represents a cross-sectional approach.

Results: The Independent t-test was used to examine the results among the groups, with a significance level set at $p \leq 0.05$. Considerable statistical changes were observed in cadence, hindfoot angle, knee flexion ROM, and hip internal rotation ROM, with corresponding p-values of 0.0006, 0.049, 0.002, and 0.01, respectively. However, no significant differences were found in the case of the WOMAC scale and VAS pain rating scale between the groups with *Genu valgum* and *genu varum* deformities, as their p-values were considerably higher than the significance level (0.169, 0.948).

Conclusion: The objective of the study was to gain insight into the biomechanical and functional condition of individuals suffering from knee osteoarthritis. Substantial differences were observed between the groups regarding cadence, hindfoot angle, knee flexion range of motion (ROM), and hip internal rotation ROM. However, when evaluating the WOMAC scale and VAS pain rating scale, both groups exhibited nearly identical values, indicating a lack of statistical significance in these outcome measures.

Keywords: Knee Osteoarthritis; *Genu valgum*; *Genu varum*; Tibiofemoral Angle; Cadence; Hindfoot Angle; Knee Flexion ROM; Hip Internal Rotation ROM; WOMAC scale; VAS scale

Abbreviations: OA: Osteoarthritis; ROM: Range of Motion; KOA: Knee Osteoarthritis; GV: *Genu varum*; PA: Physical Activity; WOMAC: Western Ontario and McMaster University Osteoarthritis Index; VAS: Visual Analogue Scale.

Introduction

Knee osteoarthritis (KOA) is a musculoskeletal condition involving degeneration of knee cartilage, resulting in pain and functional limitations. Patients with knee OA show decreased range of motion (ROM) and increased ground response force. In fact, we frequently see knee osteoarthritis patients with pathology in the hip and ankle joints. The knee deformity known as *genu varum* (GV) occurs when the mechanical axis of the lower limb crosses the middle of the knee joint. The deformity typically results from uneven pressure being applied to the medial and distal compartments of the knee, which eventually damages cartilage within the joint. *Genu valgum* is a deformity that causes a person's knees to curve inward and touch one another, giving them a "knock-knee" appearance. The proximal tibia's medial torsion, which increases the weight bearing capacity of the lateral side, is the most frequent cause of *genu valgum* [1].

Cadence is a common and simple indicator of physical activity (PA) during free-living behaviour. A cadence of 100 steps/min is moderate intensity and a cadence of 130 steps/min is vigorous intensity. Knee varus and valgus are effective on the hindfoot alignment and disrupts the coronal hip-knee-ankle alignment. Hindfoot angle is the angle between the tibial anatomical axis and the longitudinal axis of the calcaneus. The normal hindfoot angle is 2° to 6° valgus [2]. The angle was formed by the bisection of the distal one-third of the leg and a longitudinal line that bisected the posterior aspect of the calcaneus. A hindfoot angle of more than 7° was defined as excessive valgus heel alignment.

Hip joint movements like internal rotation should also change as OA in the knee with varus or valgus malalignment develops. Hip internal rotation ranges from 0-40° in gonimoteric measurements. Knee flexion is a major osteokinematic motion which ranges normally from 0-140°. In individuals affected with osteoarthritis knee usually there will be a decrease in knee flexion.

Western ontario and mcmaster universities osteoarthritis index (WOMAC) is a scale used to evaluate the disease's course or a patient's reaction to treatment in those with knee or hip osteoarthritis. There are three subscales: 1) pain severity during various positions or movements, 2) severity of joint stiffness, and 3) difficulty performing daily functional activities. The total score is of 96 in which each subscale is the sum of scores for each response to each item. Possible subscale scoring in the Likert format is: pain (0-20; 5 items each scored 0-4), stiffness (2 items, 0-8), and physical function (17 items, 0-68). The VAS pain rating scale is dependable, valid which consists of a bidirectional 10 cm straight line with two labels at either end, reading "no pain" and "worst possible pain." The scale runs from 0 to 10, with 0 denoting "no pain" and 10 denoting the "worst pain imaginable." Patients are told to select the one number on the scale that most accurately describes their level of pain [3].

This study is conducted to analyze these parameters like cadence, hindfoot angle, hip internal flexion, knee flexion, WOMAC scale and VAS pain rating scale between the groups of individuals with *genu valgum* and *genu varum* deformity. Previously there have been numerous studies on *genu valgum* and *genu varum* separately but an analysis between these deformities has not been conducted till date. There are many studies involving several outcome measures with OA knee but there has always been a lack in studies on *genu valgum* and varum deformity caused by OA knee. Analyzing these two deformities using various parameters will be helpful in creating a wide knowledge while treating a patient with knee osteoarthritis. Therefore, this study is will help to know about the biomechanical and functional status of OA knee patients with *genu valgum* and varum deformity [4].

Methodology

Study Setting: Community setting
Study Design: Cross sectional study
Sample Size: 80
Sampling Method: Convenient sampling
Study Duration: 6 months

Inclusion Criteria

- Patient diagnosed with osteoarthritis knee for the past 5 years.
- Age above 50 years.
- Only females were taken.
- OA knee patients with kellegren Lawrence scale above grade 3.

Exclusion Criteria

- Osteoarthritis caused due to factors other than aging.
- *Genu valgum* and *genu varum* caused by Osteochondrodysplasia, rickets, Blount'sz disease, infections and other congenital anomalies.
- Recently diagnosed OA patients.
- No recent injuries around knee
- Patients who have undergone knee replacement surgery.

Outcome Measures

- Cadence
- Hindfoot angle
- Knee flexion ROM
- Hip internal rotation ROM

- WOMAC scale
- VAS scale

Procedure

After ethical approval, Data were taken from the ward members and ASHA workers in Kochi taluk area (community level). Only subjects who were clinically diagnosed with knee osteoarthritis were included. The subjects were selected according to the inclusion and exclusion criteria. The nature of study, the duration of intervention and the intervention being used will be briefed to the participants. They will be encouraged to clarify queries regarding the study, if any.

A total of 80 knee OA patients were conveniently divided into two groups; one with *genu valgum* and other with *genu varum* by assessing the medial tibiofemoral angle. Operational tool used for medial tibiofemoral angle is 360° goniometer. Normal range of medial tibiofemoral angle is 180°-185°. If the angle is below 180° the patients is with *genu varum* deformity. If medial Tibiofemoral angle is above 185° then it is considered *genu valgum* deformity. Mid-point of patella is used as fulcrum. Both ASIS and mid-point of ankle is taken respectively as stationary arm and movable arm point. After classifying the patients into two groups, the following parameters were checked which are cadence in gait, decreased knee flexion, hip internal rotation, hind foot angle, WOMAC scale, VAS pain scale. The deviations in the parameters were compared between the *genu valgum* group and *genu varum* group. The data were properly studied and the conclusion was prepared accordingly.

Comparison of Cadence Value between Group A and Group B

Group	Mean	Std. Deviation	Mean Difference	t	df	Significance
genu valgum	81.31	6.18	5.11	3.55	78	p<0.05
genu varum	76.2	6.38				

Table 1: Independent t test for cadence values between *genu valgum* and *genu varum* group.

The mean column in the t test table displays the mean cadence values in *genu valgum* and *genu varum* group respectively. The difference (5.11) shows the difference between mean in two groups (81.31 and 76.20). Since the t- value, 3.55 shows p-value < 0.05, the scores in the *genu varum* group is significantly lower than that in the *genu valgum* group. This proves that there is significant effect on comparing cadence between *genu valgum* and *genu varum* groups.

Comparison of Vas Score between Group A and Group B

Group	Mean	Std. Deviation	Mean Difference	t	df	Significance
genu valgum	5.75	1.36	0.021	0.0642	78	p>0.05
genu varum	5.73	1.45				

Table 2: independent t test for VAS score values between *genu valgum* and *genu varum* group.

The mean column in the t test table displays the mean VAS score values in *genu valgum* and *genu varum* group respectively. The difference (0.021) shows the difference between mean in two groups (5.75 and 5.729). Since the t-value, 0.0642 shows p-value > 0.05, there is no significant difference in VAS score values between the *genu valgum* and *genu varum* groups. This proves that there is no significant effect on comparing VAS score values between *genu valgum* and *genu varum* group

Comparison of WOMAC Score between Group A and Group B

Group	Mean	Std. Deviation	Mean Difference	t	df	Significance
genu valgum	47.59	8.26	2.823	-1.38	78	p>0.05
genu varum	50.41	9.33				

Table 3: independent t test for WOMAC score values between *genu valgum* and *genu varum* group.

The mean column in the t test table displays the mean WOMAC score values in *genu valgum* and *genu varum* group respectively. The difference (2.823) shows the difference between mean in two groups (47.59 and 50.41). Since the t- value, -1.386 shows p-value > 0.05, There is no comparable difference between the scores in *genu valgum* and *genu varum* groups. This proves that there is no significant effect on comparing WOMAC score values between *genu valgum* and *genu varum* groups.

Comparison of Hip Internal Rotation Range of Motion between Group A and Group B

Group	Mean	Std. Deviation	Mean Difference	t	df	Significance
genu valgum	29.53	3.44	2.386	2.37	78	p<0.05
genu varum	27.14	4.92				

Table 4: independent t test for hip internal rotation range of motion values between *genu valgum* and *genu varum* group.

The mean column in the t test table displays the mean hip internal rotation ROM values in *genu valgum* and *genu varum* group respectively. The difference (2.386) shows the difference between mean in two groups (29.53 and 27.14). Since the t- value, 2.378 shows p-value < 0.05, the scores in the *genu varum* group is significantly lower than that in the *genu valgum* group. This proves that there is significant effect on comparing ROM of hip internal rotation between *genu valgum* and *genu varum* groups.

Comparison of Knee Flexion Range of Motion between Group A and Group B

Group	Mean	Std. Deviation	Mean Difference	t	df	Significance
genu valgum	118.75	6.95	5.521	3.09	78	p<0.05
genu varum	113.22	8.34				

Table 5: Independent t test for knee flexion range of motion values between *genu valgum* and *genu varum* group.

The mean column in the t test table displays the mean knee flexion ROM values in *genu valgum* and *genu varum* group respectively. The difference (5.521) shows the difference between mean in two groups (118.75 and 113.22). Since the t-value, 3.092 shows p-value < 0.05, the scores in the *genu varum* group is significantly lower than that in the *genu valgum* group. This proves that there is significant effect on comparing ROM of knee flexion between *genu valgum* and *genu varum* groups.

Comparison of Hind Foot Angle between Group A and Group B

Group	Mean	Std. Deviation	Mean Difference	t	df	Significance
genu valgum	7.03	0.93	0.427	-1.99	78	p<0.05
genu varum	7.46	0.94				

Table 6: Independent t test for hind foot angle values between *genu valgum* and *genu varum* group.

The mean column in the t test table displays the mean hindfoot angle values in *genu valgum* and *genu varum* group respectively. The standard deviation column displays the standard deviation of the scores in two groups. The difference (0.427) shows the difference between mean in two groups (7.03 and 7.45). Since the t- value, -1.991 shows p-value < 0.05, there is significant difference in hind foot angle values between the *genu valgum* and *genu varum* groups. The scores in the *genu varum* group is significantly higher than that in the *genu valgum* group. This proves that there is significant effect on comparing hindfoot angle between *genu valgum* and *genu varum* groups.

Discussion

This study was conducted to know about the biomechanical and functional status of OA knee patients with *genu valgum* and *genu varum* deformity. In this study, patients

with knee osteoarthritis were divided into two groups which are *genu valgum* and *genu varum* group by using tibiofemoral angle. Outcomes measures used in this study were cadence, WOMAC scale, VAS pain scale, hip internal rotation ROM, knee flexion ROM and hindfoot angle [5].

These were checked in each group and a comparison was taken between them. The results were analysed using t test. Independent t test was used to compare results between the groups. Significant level kept as p value ≤ 0.05.

In case of cadence, it was found that in independent t test, since t value is 3.55, shows p value ≤ 0.05(0.0006), The mean difference shows the difference between mean in two groups is 5.11. The statistical analysis of cadence shows *genu valgum* group has more significant increase when compared to *genu varum* group. Jocelyn FH, et al. [6] stated that cadence is effectively lower in osteoarthritis knee patients compared to normal individuals. In this study, cadence was seen to be higher in *genu valgum* group compared to *genu varum* group. We observed that *genu varum* group have higher base of support as a result their gait pattern is slower. Waddling gait was seen in patients with *genu varum* deformity. As a result, their cadence was much lower compared to *genu valgum* group.

In case of hip internal rotation ROM, it was found that in independent t test, since t value is 2.37, shows p value ≤ 0.05(0.01), The mean difference shows the difference between mean in two groups is 2.386. The statistical analysis of hip internal rotation ROM shows *genu valgum* group have more significant increase when compared to *genu varum* group. Ro DH, et al. [7] stated that hip ROM was reduced in knee osteoarthritis patients compared to the control group with normal individuals. *Genu valgum* deformity are already seen in mild internal rotation of hip compared to *genu varum*. *Genu varum* group have outward bending of knee which results in decreased hip internal rotation. As a result, there is significant difference in hip internal rotation ROM for *genu varum* and *genu valgum* groups.

In case of knee flexion ROM, it was found that in independent t test, since t value is 3.09, shows p value ≤ 0.05(0.002), The mean difference shows the difference between mean in two groups is 5.521. The statistical analysis of knee flexion ROM shows *genu valgum* group has more significance when compared to *genu varum* group. Janie LA, et al. [8] found out changes in peak knee flexion moment in both moderate and severe knee osteoarthritis patients. *Genu varum* group had decreased knee flexion ROM compared to *genu valgum* group. Fixed flexion deformity is commonly seen in *genu varum* deformity rather than in *genu valgum*. As a result, there will be tightness over the hamstrings muscles which will lead to reduction in knee flexion motion.

In case of Hindfoot angle, it was found that in independent t test, since t value is -1.99, shows p value ≤ 0.05(0.049), there is significant difference in hindfoot angle value between the *genu valgum* and *genu varum* groups. The mean difference shows the difference between mean in two groups is 0.427. The statistical analysis of hindfoot angle shows *genu varum* group has more significant change compared to *genu valgum* group. Ruhling M, et al. [9] stated that a varus deformity at the knee joint can lead to a hindfoot valgus and consequently to a pes planus deformity, for instance. In this study, *genu varum* patients were higher in number compared to *genu valgum* group. As a result, most of the individuals were having hindfoot valgus which normally leads to flat foot deformity (pes planus).

In case of the WOMAC scale, it was found that in independent t test, since t value -1.38, shows p value ≥ 0.05(0.169), there is no significant difference in WOMAC scale value between the *genu valgum* and *genu varum* groups. The mean difference shows the difference between mean in two groups is 2.823. The statistical analysis of WOMAC scale shows either *genu valgum* group or *genu varum* group has no significance compared with each other.

In case of VAS pain scale, It was found that in independent t test, since t value 0.064, shows p value ≥ 0.05(0.948), there is no significant difference in VAS pain rating scale value between the g*enu valgum* and *genu varum* groups. The mean difference shows the difference between mean in two groups is 0.021. The statistical analysis of VAS pain rating scale shows either *genu valgum* group or *genu varum* group has no significant change compared with each other [10-12].

Conclusion

Based on the values of the above study, the scores in the *genu valgum* group shows statistically significant increase in cadence, hip internal rotation ROM and knee flexion ROM compared to *genu varum* group. Only in the case of hindfoot angle, there is a significant increase for *genu varum* group over *genu valgum* group. The values of both the WOMAC scale and VAS pain rating scale remained largely unchanged since the scores were comparable in both groups. This study also suggests that in knee OA pateints, *genu varum* group are having more functional and biomechanical limitations compared to *genu valgum* group. As a result, this study's conclusion suggests that when examining specific outcome measures such as cadence, hip internal rotation range of motion (ROM), knee flexion ROM, and hind foot angle between the *genu valgum* and *genu varum* groups, significant differences are observed. However, the WOMAC scale and VAS pain rating scale are more valuable in determining the quality of life and the severity of pain rather than comparing changes.

References

1. Zhang L, Liu G, Han B, Yan Y, Fei J, et al. (2021) A Comparison of Dynamic and Static Hip-Knee-Ankle Angle during Gait in Knee Osteoarthritis Patients and Healthy Individuals. Appl Bionics Biomech 2021: 6231406.

2. Metcalfe AJ, Stewart C, Postans N, Dodds AL, Holt CA, et al. (2013) The effect of osteoarthritis of the knee on the biomechanics of other joints in the lower limbs. Bone Joint J 95B(3): 348-353.

3. Neila M, Delphine B, Youssef O, Alexandre F, Nicola H, et al. (2017) Biomechanical analysis to characterize the impact of knee osteoarthritis on hip, knee and ankle kinematics. Journal of Biomedical Engineering and Informatics 3(2): 36.

4. Tabrizi A, Soleimanpour J, Sadighi A, Zare AJ (2013) A short term follow up comparison of *genu varum* corrective surgery using open and closed wedge high tibial osteotomy. Malays Orthop J 7(1): 7-12.

5. Khrystyne T, Rebecca G (2020) Knock-knees: Identifying *genu valgum* and understanding its relationship to vitamin D deficiency in 18th to 19th century northern England. International Journal of Osteoarchaeology 30(6): 891-902.

6. Jocelyn FH, Julia FS, Hillstrom HJ, Boyer KA (2016) Changes in coordination and its variability with an increase in running cadence, J Sports Sci 34(15): 1388-1395.

7. Ro DH, Lee J, Lee J, Park JY, Han HS, et al. (2019) Effects of Knee Osteoarthritis on Hip and Ankle Gait Mechanics. Adv Orthop 2019: 9757369.

8. Janie LA, Kevin JD, Caldwell GE, Dunbar MJ (2007) Biomechanical changes at the hip, knee, and ankle joints during gait are associated with knee osteoarthritis severity. J orthop res 26(3): 332-341.

9. Ruhling M, Kirschbaum S, Perka C, Graef F (2023) Functional gait analysis reveals insufficient hindfoot compensation for varus and valgus osteoarthritis of the knee. Int Orthop 47(5): 1233-1242.

10. Hadi H, Jabal AM, Bagherifard A, Behrouzi A, Safi F, et al. (2020) The Effect of Total Knee Arthroplasty on Hindfoot Alignment in Patients with Severe *Genu varum* and *Genu valgum*. Arch Bone Jt Surg 8(3): 413-419.

11. Weidow J, Tranberg R, Saari T, Karrholm J (2006) Hip and knee joint rotations differ between patients with medial and lateral knee osteoarthritis: gait analysis of 30 patients and 15 controls. J Orthop Res 24(9): 1890-1899.

12. Hart HF, Birmingham TB, Primeau CA, Pinto R, Leitch K, et al. (2021) Associations Between Cadence and Knee Loading in Patients With Knee Osteoarthritis. Arthritis Care Res (Hoboken) 73(11): 1667-1671.