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A comparison of results of 3-dimensional gait analysis and observational gait analysis in patients with knee osteoarthritis

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Objective: This study aimed to investigate levels of validity, and inter- and intra-observer reliability of observational gait analysis (OGA) in clinical usage, done by the physical therapists with varying clinical experience, in subjects with knee osteoarthritis.

Methods: The study included 33 subjects (22 female, 11 male; mean age: 58.24±9.14 years range: 46 to 81) clinically and radiographically diagnosed with bilateral knee osteoarthritis, and 4 physical therapists to observe the subjects' gaits. The physical therapists were separated into two groups according to their professional experience: those with 10 or more years, and those with fewer than 10 years. Video recordings were made of the subjects undergoing three-dimensional gait analysis (3DGA). These recordings were then observationally assessed twice by the participating physical therapists with at least a 6-week interval between observations. OGA was done via a form comprising 11 kinematic and 5 temporo-spatial parameters.

Results: Lowest levels of agreement in both validity ($r=0.06$, $p>0.05$), and inter- (ICC:–0.12-0.06) and intra-observer (ICC:0.30–0.45) reliability were found in the parameters of ankle dorsiflexion in initial contact phase and pelvic rotation in midstance phase. Highest inter- and intra-observer agreement was found in the temporo-spatial parameters of step width, double step length, cadence and velocity (ICC:0.61–0.80). Highest validity was found in pelvic tilt in stance phase ($r=0.74–0.78$, $p<0.001$). With the exception of stance phase, moderate or good agreement ($r=0.52–0.69$, $p<0.05$) was found in the temporo-spatial parameters.

Conclusion: This study found that OGA assessment of temporo-spatial parameters had moderate or good validity and reliability. Assessment of the majority of kinematic parameters had fair or moderate validity and inter-observer reliabilty, and moderate or good intra-observer reliability.

Keywords: Gait analysis; observational gait analysis; osteoarthritis; reliabilty; validity.

Knee osteoarthritis (OA) is the most common joint disease in the older population,[1] and the resulting changes in intraarticular and extraarticular structures and joint deformities cause different gait disorders.[2,3]

Gait analysis is used in clinics to diagnose gait disorders due to musculo-skeletal and neurological system pathologies, and to determine correct and effective treatment programmes. Although a number of methods for

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gait analysis are referred to in the literature, observational gait analysis (OGA) is preferred by clinics because it is a fast, simple and inexpensive method.[4]

Although OGA is often used for a variety of clinical purposes, the number of studies investigating its reliability and validity is limited. These studies mostly include patient groups with neurological diseases such as hemiplegia,[5] cerebral palsy,[6-9] traumatic brain damage[10] and spinal cord injury.[11] The literature review for this study found two studies investigating the reliability of OGA in orthopedic patient groups, but did not find any studies investigating its validity in these groups.[12,13] Moreover, the results of existing studies show variety. The literature review also revealed that most previous studies were done with neurological patients, and that no studies have been done in which intra- and inter-observer agreement in OGA of orthopaedic patients was compared with 3D gait analysis and correlated with the clinical experiences of physical therapists.

As a result, this study had a twofold purpose: to investigate, using a prepared form, the level of validity, and intra- and inter-observer reliability of the clinical use of OGA in patients with knee OA, and to investigate the effects of professional experience on the validity and reliability of OGA.

Patients and methods

This study was conducted with 33 subjects (22 female, 11 male; mean age: 58.24±9.1 years range: 46 to 81) diagnosed with bilateral knee OA, and 4 physical therapists, who assessed by observation the gaits of the subjects. Subjects with each of the four grades of knee OA outlined in the Kellgren & Lawrence (KL) radiological classification were included in the study. Of the 66 knees, 15 had grade I knee OA, 30 had grade II, 16 had grade III and 5 had grade IV. Criteria for inclusion were: bilateral knee OA, no background of lower extremity operation or major trauma, no orthopaedic knee injuries like tendinopathy, bursitis, ligaments and meniscus injuries, no neurological disease affecting gait, no rheumatic disease such as rheumatoid arthritis or gout, and no OA involving other lower extremities. Approval for the study was granted by Hacettepe University Non-Interventional Clinical Researches Ethics Board and subjects provided written informed consent on the admission.

Gait analysis records were tracked in the gait analysis laboratory of the Department of Physical Medicine and Rehabilitation at Hacettepe University. All kinematic data were recorded using 6-infrared digital cameras (50Hz) and two side-by-side force plates (Bertec Force Plate, USA) on the 8×4 m laboratory walkway. Data analysis was carried out with VICON Motion Systems (Workstation Version 4.0, Oxford, UK). In accordance with the Vicon Clinical Manager protocol,[14,15] reflective indicators were placed on specific anatomical regions of the subjects before gait. Temporo-spatial and kinematic values were calculated by taking the arithmetic mean of 5 ideal trials recorded in the same gait session. Subjects were asked to walk at a self-selected comfortable speed.

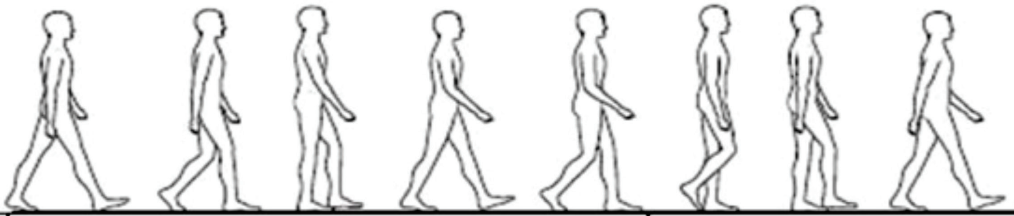
In accordance with the manner recommended in the literature,[14,16] while subjects were being evaluated in the 3DGA, their movements were being recorded from the front, back, and right and left lateral sides using a Canon PowerShot SX40 HS digital camera with 24-840 mm focal length, 35X zoom and 2.7-5.8. When recording from front and back, the camera was placed 2 m distant from the subject in the direction of the gait. When recording from right and left lateral sides, the camera was placed 4 m away from subject's gait path and positioned vertically to it. Camera height was fixed according to the length of subjects' lower extremities. Subjects walked barefoot, and were asked to wear shorts so that joint movements could be observed, and T-shirts so as to observe pelvic eminentia (SIPS and SIAS).

OGA was done twice by the 4 participating physical therapists at 6-week intervals. The therapists were grouped according to years of professional experience: Group 1 comprised those with fewer than 10 years, and Group 2 those with 10 years or more. The two therapists in Group 1 had 3 and 6 years of professional experience, and the two in Group 2 had 12 years and 16 years. All the therapists frequently treated patients with knee OA, and regularly used OGA in clinical assessment of their patients. Prior to the assessments, the physical therapists took part in a 3-hour course on the OGA form that would be used, gait analysis with video records, and the characteristics of normal and pathological gaits.

Assessments were made according to the subjects' video records. No time limit or viewing restrictions were imposed upon the observers. They could review, slow down or freeze the video records as they wished. The OGA was done on a form designed by the study authors. This form comprised 16 parameters; 11 angular and 5 temporal. Considering the peak value of the determined phases, each observer was asked to indicate the parameters as significantly decreased (–2), slightly decreased (–1), normal (0), slightly increased (1) or significantly increased (2). Each assessment was done for right and left extremities. Normal values were given in the form to serve as reference. For ease of use, sections to be checked for every parameter were indicated by a white area, with other sections marked in grey (Fig. 1).

Statictical analyses were carried out with SPSS for Windows V.10.0.1. Demographic data and gait analysis parameters were calculated by descriptive analysis and were shown as mean (MD) ±standart deviation (SD). Using the Intraclass correlation coefficients test and absolute agreement based on the two-way random model, coherence between the results of the gait assessment of the patients and inter-rater and intra-rater agreement was investigated.

Correlation coefficient was used to calculate the relation between 3DGA results and OGA results, and statistical significances were assessed with the Spearman



2: Significant Increased
1: Slight Increased
0: Normal
-1: Slight Decreased
-2: Significantly Decreased

		STANCE PHASE					SWING PHASE		
		Initial Contact	Loading Response	Midstance	Terminal Stance	Preswing	Initial Swing	Midswing	Terminal Swing
PELVIS	Internal/ External Rotation	←Neutral→		←5° Int Rot→	←Neutral→		←5° Ext Rot→		←Neutral→
	Pelvic Tilt	←10° Ant→					←10° Ant→		
	Pelvic Obliquity	←Neutral→		←5° Ele→	←Neutral→		←5° Dep→	←Neutral→	
HIP	Hip Flx.							←35° Flx→	
	Hip Ext.				←10° Ext→				
	Hip Abd/Add	←Neutral→	←5° Add→			←Neutral→	←5° Abd→		←Neutral→
KNEE	Knee Flx.	←5° Flx→	←15° Flx→		←3° Flx→		←65° Flx→		←5° Flx→
FOOT	Plantar Flexion					←10° Flx→			
	Dorsi Flexion	←Neutral→		←10° Flx→	←15° Flx→			←Neutral→	
	Foot Ankle			←15°→					
TEMPORAL DATA	Stance Phase Lenght	RIGHT		LEFT		62%			
	Step Width	RIGHT		LEFT		20 cm			
	Double Step Lenght					120-140 cm			
	Cadence					120-136 step/mn			
	Velocity					1.09-1.41 mt/mn			

Fig. 1. OGA Form. İnt. Rot: İnternal ratation; Ext Rot: External rotation; Ant: Anterior pelvic tilt; Ele: Elevation; Dep: Depresion; Flx: Flexion; Ext: Extention; Abd: Abduction; Add: Adduction.

test. Results were assessed with p<0.05 level of significance and %95 of confidence interval.

Agreement in correlation analysis and ICC were classified as follows:

- 0–0.20 poor agreement
- 0.21–0.40 fair agreement
- 0.41–0.60 moderate agreement
- 0.61–0.80 good agreement
- 0.81–1.00 very good agreement

Results

The mean age and mean body mass index (BMI) of the 33 subjects with knee OA included in this study were 58.24±9.1 years and 30.59±5.37 kg/m^2 respectively. Other demographic data and radiological classification results can be seen in Table 1. The statistical results of temporo-spatial and 11 specific phase peak angular values obtained using kinematic data analysis of the subjects' 3DGA are given in Table 2.

The results for intra- and inter-observer reliability obtained from the statistical investigation of OGA data are presented in Table 3. Good intra-observer agreement was found in parameters of pelvic tilt at stance phase (ICC:0.68–0.80), hip adduction at loading response (ICC:0.71–0.77), knee flexion at terminal stance (ICC:0.58–0.66), knee flexion at swing phase (ICC:0.62–0.63), ankle plantarflexion at preswing phase (ICC:0.61–0.64), and ankle angle at midstance phase (ICC:0.72–0.75). Moderate intra-observer agreement was found in parameters of pelvic oblique at midstance phase (ICC:0.52–0.57), hip flexion at midswing

Table 1. Demographic characteristics of subjects.

	Mean±SD				
Age (year)	58.24±9.1				
Height (m)	1.58±0.01				
Weight (kg)	77.23±11.73				
Body mass index (kg/m^2)	30.59±5.37				
Radiological phase	**Phase 1 n (%)**	**Phase 2 n (%)**	**Phase 3 n (%)**	**Phase 4 n (%)**	**Total n**
Right knee	7 (21.2)	16 (48.5)	8 (24.2)	2 (3)	33
Left knee	8 (24.2)	14 (42.4)	8 (24.2)	3 (9)	33

SD: Standard deviation; m: Meter; kg: Kilogram; %: Percent.

Table 2. 3DGA data on subjects.

Gait parameters	Right extremity	Left extremity
	Mean±SD	Mean±SD
Pelvic internal rotation at midstance phase (°)	4.18±5.57	2.18±3.14
Pelvic tilt at stance phase (°)	13.48±6.83	12.94±6.85
Pelvic elevation at midstance phase (°)	2.64±3.15	2.67±2.64
Hip flexion at midswing phase (°)	32.06±5.25	31.97±5
Hip extension at terminal stance phase (°)	10.45±5.62	9.18±6.72
Hip adduction at loading response phase (°)	5.90±3.82	5.51±3.97
Knee flexion at terminal stance phase (°)	1.67±4.88	1±4.02
Knee flexion at preswing phase (°)	42.42±10.5	41.41±11.43
Ankle plantarflexion at preswing phase (°)	11.73±5.22	11.42±5.41
Ankle dorsiflexion at initial contact phase (°)	1±3.31	1±3.38
Foot angle at midstance phase (°)	9.15±4.29	8.15±5.35
Stance phase length (%)	62.67±2.76	64.06±3.17
Step width (cm)	19.51±4.95	20.6±3.75
Double step length (cm)	106±16	
Cadence (step/mn.)	106±11.2	
Velocity (m/sn)	0.94±0.19	

SD: Standart deviation; °: Degree; %: Percent; cm: Centimeter; mn: Minute; sn: Second; m: Meter.

phase (ICC:0.58–0.60) and hip extension at terminal stance phase (ICC:0.47–0.52) (Table 3).

Fair or moderate inter-observer agreement was determined in parameters of pelvic oblique at midstance phase (ICC:0.22–0.46), hip flexion at midswing phase (ICC:0.39–0.45), hip extension at terminal phase (ICC:0.33–0.38), hip adduction at loading response phase (ICC:0.40–0.48), ankle plantarflexion at preswing phase (ICC:0.58–0.61) and ankle angle at midstance phase (ICC:0.37–0.41). Poor inter-observer agreement was found in parameters of pelvic rotation at midstance phase (ICC:–0.12–0.09) and ankle dorsiflexion at initial contact phase (ICC:0.05–0.10) (Table 3).

Validity results investigating the relation between 3DGA and OGA are shown in Table 4. Poor validity was found in parameters of pelvic rotation and pelvic elevation at midstance phase (r=0.03–0.15, p>0.05), hip flexion at midswing phase (r=0.04–0.05, p>0.05) and ankle dorsiflexion at initial contact phase (r=0.07–0.09, p>0.05). Fair or moderate validity was found in parameters of hip extension at terminal stance phase (r=0.28–0.34, p<0.05), hip adduction at loading response (r=0.38–0.41, p<0.05), foot angle at midstance phase (r=0.57–0.59, p=0.00) and ankle plantarflexion at preswing phase (ICC:0.47–0.56, p=0.00) (Table 4).

The statistical analysis results of temporo-spatial parameters obtained from both gait analyses show good intra- and inter-observer agreement in terms of step width (ICC:0.64–0.80), double step length (ICC:0.62–0.79), cadence (ICC:0.61–0.74) and velocity (ICC:0.67–0.80). Validity was found to be moderate or good in these parameters (r=0.54–0.69, p≤0.001) (Tables 3 and 4).

The intra- and inter-observer reliablity and validity results of the assessed parameters were similar for all 4 therapists.

Discussion

The results of this study indicate poor or moderate validity and reliability for almost all the evaluated angle parameters. Although our validity results are similar to those in the literature,[9,10,17] our reliability results are different in several aspects.[6-8,12] In their study with a patient group with various lower extremities injuries, Brunnekreef et al. indicated moderate or good inter-observer agreement (ICC:0.40–0.66), and good or very good intra-observer agreement (ICC:0.63–0.87).[12] Mackey et al. reported moderate, good or very good validity (Weighted kappa/wk:0.38–0.94), intra-observer (wk:0.30–1.00) and inter-observer (wk:0.29–1.00) agreement in their study including children with cerebral palsy.[6] Toro et al. reported good intra-observer (%75) agreement and inter-observer (%77) in their study done

Table 3. Results of inter- and intra-observer agreement.

Parameters	Interobserver agreement		Intraobserver agreement	
	Less experienced group	Experienced group	Less experienced group	Experienced group
	ICC*	ICC*	ICC*	ICC*
Pelvic rotation at midstance phase (°)	0.09[a] (-0.08-0.27)	-0.12[a] (-0.33-0.11)	0.28[b] (0.07-0.47)	0.41[c] (0.18-0.58)
Pelvic tilt at stance phase (°)	0.78[d] (0.65-0.87)	0.71[d] (0.64-0.77)	0.68[d] (0.49-0.79)	0.80[d] (0.71-0.86)
Pelvic obliquity at midstance phase (°)	0.22[b] (-0.03-0.44)	0.46[c] (0.16-0.66)	0.57[c] (0.39-0.71)	0.52[c] (0.34-0.69)
Hip flexion midswing phase (°)	0.45[c] (0.33-0.62)	0.39[b] (0.08-0.61)	0.60[c] (0.44-0.76)	0.58[c] (0.39-0.72)
Hip extension at terminal stance phase (°)	0.38[b] (0.07-0.60)	0.33[b] (0.09-0.53)	0.52[c] (0.32-0.67)	0.47[c] (0.26-0.64)
Hip adduction at loading responce phase (°)	0.40[b] (0.21-0.57)	0.48[c] (0.30-0.67)	0.71[d] (0.60-0.78)	0.77[d] (0.64-0.85)
Knee flexion at terminal stance phase (°)	0.32[b] (0.12-0.60)	0.37[b] (0.15-0.56)	0.58[c] (0.38-0.72)	0.66[d] (0.47-0.76)
Knee flexion at swing phase (°)	0.54[c] (0.36-0.71)	0.59[c] (0.41-0.72)	0.62[d] (0.43-0.82)	0.63[d] (0.49-0.75)
Ankle plantarflexion at preswing phase (°)	0.58[c] (0.33-0.71)	0.61[d] (0.43-0.74)	0.61[d] (0.35-0.78)	0.64[d] (0.47-0.76)
Ankle dorsiflexion at initial contact phase (°)	0.10[a] (-0.13-0.33)	0.05[a] (-0.15-0.26)	0.17[a] (-0.06-0.26)	0.37[b] (0.13-0.56)
Foot angle at midstance phase (°)	0.41[c] (0.16-0.59)	0.37[b] (0.02-0.62)	0.75[d] (0.60-0.84)	0.72[d] (0.60-0.81)
Stance phase length (%)	0.13[a] (-0.13-0.32)	0.19[a] (0.04-0.34)	0.55[c] (0.40-0.67)	0.56[c] (0.36-0.68)
Step width (cm)	0.66[d] (0.34-0.83)	0.64[d] (0.47-0.76)	0.80[d] (0.70-0.86)	0.75[d] (0.60-0.86)
Double step length (cm)	0.67[d] (0.43-0.82)	0.62[d] (0.46-0.77)	0.73[d] (0.56-0.84)	0.79[d] (0.62-0.88)
Cadence (step/mn.)	0.64[d] (0.39-0.81)	0.61[d] (0.48-0.74)	0.66[d] (0.51-0.82)	0.74[d] (0.55-0.86)
Velocity (m/sn)	0.74[d] (0.56-0.85)	0.67[d] (0.40-0.83)	0.80[d] (0.62-0.89)	0.74[d] (0.54-0.87)

ICC: Correlation data obtained by Intraclass Correlation Coefficients Test; a: Poor agreement; b: Fair agreement; c: Moderate agreement; d: Good agreement; °: Angular degree; %: Percent; cm: Centimeter; mn: Minute; m: Meter; sn: Second.

Table 4. Results of agreement between OGA and 3DGA.

Parameters	Validity			
	Less experienced group		Experienced group	
	r**	p	r**	p
Pelvic rotation at midstance phase (°)	0.08[a]	0.662	0.06[a]	0.644
Pelvic tilt at stance phase (°)	0.74[d]	0.000*	0.78[d]	0.000*
Pelvic obliquity at midstance phase (°)	0.03[a]	0.831	0.15[a]	0.243
Hip flexion at midswing phase (°)	0.04[a]	0.773	0.05[a]	0.703
Hip extension at terminal stance phase (°)	0.34[b]	0.006*	0.28[b]	0.026*
Hip adduction at loading responce phase (°)	0.38[b]	0.003*	0.41[c]	0.001*
Knee flexion at terminal stance phase (°)	0.31[b]	0.011*	0.21[b]	0.096
Knee flexion at swing phase (°)	0.21[b]	0.095	0.25[b]	0.045*
Ankle plantarflexion at preswing phase (°)	0.47[c]	0.001*	0.56[c]	0.000*
Ankle dorsiflexion at initial contact phase (°)	0.07[a]	0.619	0.09[a]	0.559
Foot angle at midstance phase (°)	0.59[c]	0.000*	0.57[c]	0.000*
Stance phase length (%)	0.36[b]	0.001*	0.42[c]	0.000*
Step width (cm)	0.61[d]	0.000*	0.67[d]	0.000*
Double step length (cm)	0.64[d]	0.000*	0.68[d]	0.000*
Cadence (step/mn)	0.54[c]	0.001*	0.58[c]	0.000*
Velocity (m/sn)	0.66[d]	0.000*	0.69[d]	0.000*

*p<0.05 (Spearman test); **r: Correlation Coefficient; a: Poor relation; b: Fair relation; c: Moderate relation; d: Good relation; °: Angular degree; %: Percent; cm: Centimeter; mn: Minute; sn: Second; m: Meter.

with hemiplegic, diplegic and quadriplegic cerebral palsy children.[7] In their study done with diplegic cerebral palsy subjects,[8] Viehweger et al. found that OGA had good or very good intra-observer (ICC:0.59–0.96) and moderate inter-observer (%57.1) agreement.

Our obtaining lower reliability values compared to the literature may be due to different study plans, such as difference of assessed patient groups, differences of assessment form and rating system. Most studies in the literature are on neurological diseases such as, for example, children with cerebral palsy. In subjects with knee OA, while pathological changes, occurring in kinematic parameters of gait, increase depending on the increase of severity of OA, these does not cause the kind of significant gait disorders seen in severe neurological disease.[2,3,18-20] This situation may increase the observability of gait disorders in neurological patients. Brunnekreef et al. indicated that one of the reasons for the decrease in reliability results of OGA in orthopaedic patients was the irregular gait pattern seen in this patient group,[12] a factor which may also have affected our study results. One significant symptom of knee OA is knee stiffness. In patients who experience stiffness throughout the day, gait distortion, which may increase after the first two steps, may decrease later. This situation may have caused difficulty in marking, or our observers may not have assessed according to same gait cycle.

One reason for the decrease in reliability and validity was thought to be due to the high BMI of the patients, which may have resulted in the amount of soft tissue on the pelvis and abdomen obstructing vision of the bone spurs which were the moment reference for observers, thus reducing the possibility of recognizing angle deviation of joints. With the information obtained from the participating physical therapists and with our clinical experience, it is thought that high BMI also may have prevented visibility of the positon of the hip during gait, thus making it difficult to understand the relation between the positions of the body, hip and extremity (Fig. 2).

Another reason reliability findings lower than those in the literature may be due to variations in our rating system. Three (decreased, normal, increased) or two (yes, no) rating systems appear in most studies.[12] A low variation rating system shows a possible increase in making a common decision in assessment of the significant gait disorders seen in neurological patients. Using a five rating system (significantly decreased, slightly decreased, normal, slightly increased, significantly increased) in our study may have caused the lower reliability results by making the co-decision procedure difficult in our patient group.

Decreased validity and reliability may be due to the video recording used. It is hard to observe rotational movement in transverse plane with two dimensional

Fig. 2. High BMI may have prevented recognition of hip position during gait thus making it difficult to understand relation between positions of body, hip and extremity. [Color figures can be viewed in the online issue, which is available at www.aott.org.tr]

video records.[15] This may be why the lowest validity and reliability occurred in the pelvic rotation movement, which occurs in a very short time and with a minimal angle in midstance phase. Another limitation of video record method is in the sagittal plane. Ankle plantar and dorsiflexion, hip flexion and extension, and knee flexion movements that occur in the sagittal plane can be best observed straight across from the camera.[15] When moved away from the camera, the possibility of an observer's lapse increases. One record, made from right and left side, was used for assessment in the sagittal plane. It was impossible to record straight across from the camera seven moves to be evaluated in the sagittal plane. This may have misled the observers, and thus caused the decrease in validity and reliability for ankle, knee and hip movements. When recording, starting gait from different start points may be a good solution for this problem in the sagittal plane. This must be taken into consideration in later studies. The decrease in validity and reliability may also have occurred because generally the people making these assessments use OGA simultaneously in clinical usage and do not use assessment of gait with video record as a routine method. Irrespective of the knowledge the assessors had about normal and pathological gait, they were unaccustomed to the filming protocol of normal and pathological gait.

Among the parameters assessed in this study, it was temporo-spatial parameters, with the exception of stance phase duration, which showed highest validity and reliability. In the literature, while all studies about validity and reliability of OGA investigated kinematic parameters, few studied temporo-spatial parameters. Mackey et al. reported fair or moderate validity and reliablity agreement (k:0.29–0.57) in step width. Brunnekreef et al. investigated stance phase length in their study and found very good intra- (ICC:0.86) and good inter-observer (ICC:0.62) agreement in a senior group.[12] Martin et al. indicated moderate inter-observer agreement (ICC:0.49) in step width parameter.[21]

Temporo-spatial parameters having significantly higher validity and reliability results than kinematic parameters is thought to be because of the quality of evaluated parameters. While short-timed changes in some phases of gait are evaluated in kinematic parameters, time and distance are evaluated in temporo-spatial parameters. In temporo-spatial parameters, having either a long movement interval or long procession time may increase observability. Another reason may be that, unlike kinetic parameters, temporo-spatial parameters do not have limitations when assessing with video records. Factors causing lower validity and reliability in kinematic parameters, such as the observed joint being covered with clothes, high BMI, or more remote observation by camera, do not negatively affect assessment of temporo-spatial parameters.

Contrary to popular belief, and to our predictions, there was no difference in the validity and reliability results between the two groups (less-experienced and more-experienced) of physical therapists. Our literature review revealed a close resemblance between the results of our study and those of other studies with this aim.[10,12,17,22] This may be due to an incorrect manner of questioning the effect of professional experience on OGA. In these other studies, the validity and reliability of OGA was examined using angle parameters independent of each other. Independent from the educational background of the physical therapists, and the experience of the other professional groups, seeing angle deviation similarly in assessed subjects is normal. When viewed from this aspect, and except in the detection of angle deviation, a difference was expected between the experienced group and inexperienced group in making a correlation between angle deviations, and in interpreting this. Another reason why there was not a significant difference between the physical therapist's results may be the small difference in their professional experience. This has been seen as a limitation of the study.

In conclusion, this study found moderate and good validity and reliability in the temporo-spatial parameters assessed, and fair or moderate validity and interobserver reliability, and moderate and good intra-observer reliability in most of the kinematic parameters assessed. Factors that reduce validity and reliability of OGA include unclear gait disorders, joint stiffness and resultant inconsistent gait pattern, high BMI and the resultant difficulty in observing the bone spurs which are references to movement and correlation between body and extremities, and problems revealed by the video recording method. Validity and reliability will be higher in an OGA done using a form that includes the basic parameters of gait and is graded with lower variation, and using records taken by positioning the camera at the height of the observed joint and along the movement line.

Most of the subjects in this study had low and moderately severe knee OA. In subjects with severe knee OA, gait disorder is more prominent, and thus it is easier to detect gait deviations. Hence, having more subjects with the severe form could have changed the results of the study. Similarly to the literature, in this study OGA was done with video records. If OGA could have been done in real time when assessing subjects with 3DGA, more true inquiries about the validity and reliability of OGA would have been made. However, this was impossible in practice. Moreover, it is impossible to determine intra-observer reliability with this method. Further studies that include diseases with different pathology and greater numbers of observers with more varied professional experience are needed.

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