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# Comparative analysis between visual and computerized photogrammetry postural assessment

## Análise comparativa entre avaliação postural visual e por fotogrametria computadorizada

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## Abstract

**Objectives:** To compare the interobserver agreement between visual and photogrammetry postural assessment and to determine whether the quantitative photogrammetry results correspond to the symmetries and asymmetries detected through qualitative visual postural assessment. **Methods:** Twenty-one volunteers (mean age 24±1.9 years) were visually evaluated by three experienced physical therapists, who completed a postural assessment form. The participants' face and whole body were then photographed in the anterior and posterior frontal and sagittal planes. The photographs were used to draw angles from markers fixed to the skin at various anatomical points that are frequent references in traditional postural assessment. These photographs were analyzed by three examiners (other than the ones who performed the visual assessment). The agreement in each postural assessment method was determined using Cramer's V or the Phi coefficient, with the significance level set at 5%. **Results:** There was agreement between the examiners who used photogrammetry, for all segments analyzed. No agreement was found for the labial commissure (p=0.00), acromioclavicular joint (p=0.01), sternoclavicular joint (p=0.00), anterior and posterior iliac spines (p=0.00 and p=0.01) or inferior angle of the scapula (p=0.00) when assessed visually. The comparison between photogrammetry and visual postural assessment showed that the agreement level between the two assessment methods was poor for some segments of the lower limb and pelvis. **Conclusions:** Under these experimental conditions, the photogrammetry data were not correlated with the results from the visual postural assessment. The visual postural assessment produced data that were in less agreement than the photogrammetry data, and its use as a gold standard must be questioned.

**Key words:** photogrammetry; posture; assessment; validity; physical therapy.

## Resumo

**Objetivos:** Comparar a concordância interobservador da avaliação postural visual e por fotogrametria e verificar se os resultados quantitativos da fotogrametria correspondem à detecção de simetrias e assimetrias pela avaliação postural visual qualitativa. **Métodos:** Vinte e um voluntários (24±1,9 anos) foram inicialmente avaliados visualmente por três fisioterapeutas experientes que preencheram um protocolo de avaliação postural. Em seguida tiveram fotografados a face e o corpo todo nos planos frontal anterior, posterior e sagital. As fotos foram utilizadas para traçar ângulos a partir de marcadores fixados à pele, em vários pontos anatômicos, que são referências frequentes na avaliação postural tradicional. Essas fotografias foram analisadas por três examinadores diferentes da avaliação postural visual. A concordância de cada método de avaliação postural foi avaliada pelos Coeficientes de Cramer V ou de PHI, considerando-se um nível de significância de 5%. **Resultados:** Foi encontrada uma concordância entre os examinadores que utilizaram a fotogrametria para todos os segmentos avaliados. Não apresentaram concordância os segmentos comissura labial (p=0,00), acrômio clavicular (p=0,01), esternoclavicular (p=0,00), espinhas ilíacas anterior e posterior (p=0,00 e p=0,01) e ângulo inferior da escápula (p=0,00), que foram analizados por meio da avaliação postural visual. A comparação entre a fotogrametria e a avaliação postural visual demonstrou que o grau de concordância entre os dois métodos de avaliação foi pouco significativo para alguns segmentos do membro inferior e pelve. **Conclusões:** Nessas condições experimentais, os dados da fotogrametria não podem ser correlacionados com os dados da avaliação postural visual. A avaliação postural visual apresentou dados menos concordantes do que a fotogrametria, devendo ser questionada sua utilização como *gold-standart*.

**Palavras-chave:** fotogrametria; postura; avaliação; validade; fisioterapia.

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# Introduction

There is a consensus on the importance of identifying postural changes and imbalance during clinical exams[1,2] and while planning kinesiotherapy programs to minimize or reverse these changes[3]. The classic postural assessment, i.e. the assessment taught in undergraduate courses and normally carried out by physical therapists, is based on visual analysis by means of qualitative observation of the curvatures of the spine and of body asymmetries in the lateral view, as well as the anterior and posterior views[4-7]. Postural assessment by means of photographic images has been used by various researchers[8-20], although some still use this resource for record keeping and for a qualitative evaluation, i.e. to detect and document the presence of asymmetries[11,13,16] without the use of a tool to quantify these deviations. However, with the current technological advances, the use of analog and digital photography is being considered for quantitative postural assessment. This is called photogrammetry or biostereometry[21].

Because qualitative evaluation does not allow the detection of minor postural changes[22] and may lead to errors and variations between different examiners[1], it is important to demonstrate that computerized photogrammetry is a method of postural assessment in clinical practice and to accomplish each stage of the validation of this tool. Some authors have already stated this concern and tested the reliability of photogrammetry[9,12,23]. Sato, Vieira and Gil Coury[12] verified the reliability of photogrammetry in order to measure anterior trunk flexion; Iunes et al.[9] verified intra- and interobserver reliability in measuring facial and full body angles in the lateral view using photographs; and Ribeiro et al.[23] tested the reliability of photo-podometry and of photo-podoscopy. All these authors found acceptable reliability values for the studied angle measures, showing that the technique has an error which is usually acceptable in the repetition of the measurements in the same photograph. The sensitivity of photogrammetry was described by Döhnert and Tomasi[24].

Since the method can be considered reliable, there is a need to verify the agreement between visual and photogrammetry postural analyses. In other words, will photogrammetry replicate the findings of a visual postural assessment? According to Pereira[11], there is coherence between both assessment methods. Nevertheless, the author used a single examiner and only described the existence or absence of coherence between the findings. Based on these considerations, the present study aimed to: 1) verify the qualitative agreement between the examiners who carried out the visual postural assessment; 2) verify the qualitative agreement between the different examiners who carried out the postural assessment through photogrammetry; 3) compare the agreement between the visual postural assessment carried out by three physical therapists and the postural assessment carried out through computerized photogrammetry by three other physical therapists.

# Methods

## Sample

Twenty-one undergraduate students aged 22 to 26 were selected among the students enrolled at Universidade de Alfenas (UNIFENAS), being four males and 17 females. Inclusion criteria were good overall health, no report of pain, systemic disease or neurologic disease, no evident musculoskeletal injuries or deformities during evaluation, and agreement to take part in the study. The criteria for exclusion were the presence of scoliosis and hyperkyphosis with an accentuated deformity, reports of musculoskeletal pain and/or joint stiffness detected by changes in movements. All participants received information concerning the project and signed a consent form, agreeing to take part in the research, in accordance with Resolution 196/96 of the National Health Council. The experimental protocol, number 75/2003, was approved by the Human Research Ethics Committee of UNIFENAS.

## Visual postural assessment

Initially, the participants were qualitatively evaluated in swimsuits by three examiners (physical therapists) with an average of six years of professional experience in the field of musculoskeletal disorders. The examiners received an assessment form and were asked to mark the standardized options corresponding to the observation. The three examiners evaluated the participants at the same time, in the same lighting conditions and photographic angle and 1 m away from the participant. The examiners were previously trained to perform this postural assessment and they had no contact with each other during the assessment. The assessment form contained the same items evaluated by photogrammetry, which was carried out by three other examiners. No anatomic points were marked on the participant's body to reproduce the visual postural assessment. They were asked to remain in a natural posture and gaze at the horizon with the upper limbs to the side. Both the postural assessment and the photographic record were carried out without the aid of a plumb line or a symmetrograph.

## Photographic record

Photographs were taken of the face and body in the anterior, posterior and left lateral views. The participants wore swimsuits following the protocol described by Iunes et al.[9] for marking the points of reference, instrumentation, positioning of the participant, collection environment and data analysis. All photographs were taken by the same photographer, and the markers were always positioned by the same tester. A digital camera (SONY – MAVICA FD 200) was placed on a tripod 2.4 m away from the participant and 1 m off the floor in order to capture the entire body. The pictures of the face were taken using the same camera placed 94 cm away from the participant and 1.53 m from the floor, according to Iunes et al.[9]. Participants of low stature stood on a wooden platform for a better position for the photographic record. The camera was always focused on the central portion of the body, thus avoiding any distortions[25].

## Data analysis

### *Photogrammetry*

The following angles were drawn, according to the reports by Iunes et al.[9] and Iunes[25], to analyze posture symmetry: anterior view - anterior superior iliac spine (AS), Thales triangle (ΔT) (distance between the elbow and the trunk) and knee angles (KA); in the posterior view - the inferior angle of the scapula (IS), posterior superior iliac spine (PS), popliteal lines (PL) and foot angles (FA) (Figure 1).

The following angles were analyzed in the facial photographs: external orbicular (EO); labial commissure (LC); acromioclavicular joint (AJ); sternoclavicular joint (SJ) (Figure 2).

Each angle in the facial and full body photographs in the anterior and posterior views was determined by the intersection of the straight line between corresponding anatomical landmarks and the horizontal straight line parallel to the ground (determined by the analysis program), except for the ΔT angle, formed by the intersection of the straight line which passes through the medial border of the upper limb with the straight line that passes adjacent to the waist[9,25]. In the lateral view, the angles are named as follows: head protrusion (HP); cervical lordosis (CL); thoracic kyphosis (TK); lumbar lordosis (LL); pelvic tilt (PT); knee flexion (KF); tibiotarsal angle (TTA) (Figure 1).

The digital photographs were analyzed by the software ALCimagem-2000 Manipulating Images 1.5 that draws the digital straight lines that determine the angle values in degrees. The sequence of the angle analysis was randomly decided by draw. Three experienced examiners other than those who had carried out the visual postural evaluation received instructions on the software's standard measurement procedures. Each examiner took three consecutive measurements of each angle and repeated the procedure of drawing the straight lines and noting down the angle values. The values of each analyzed angle correspond to the arithmetic mean of these three measurements. Based on this quantitative analysis, the analyzed segments (EO, LC, SJ, AJ, AS, IS,

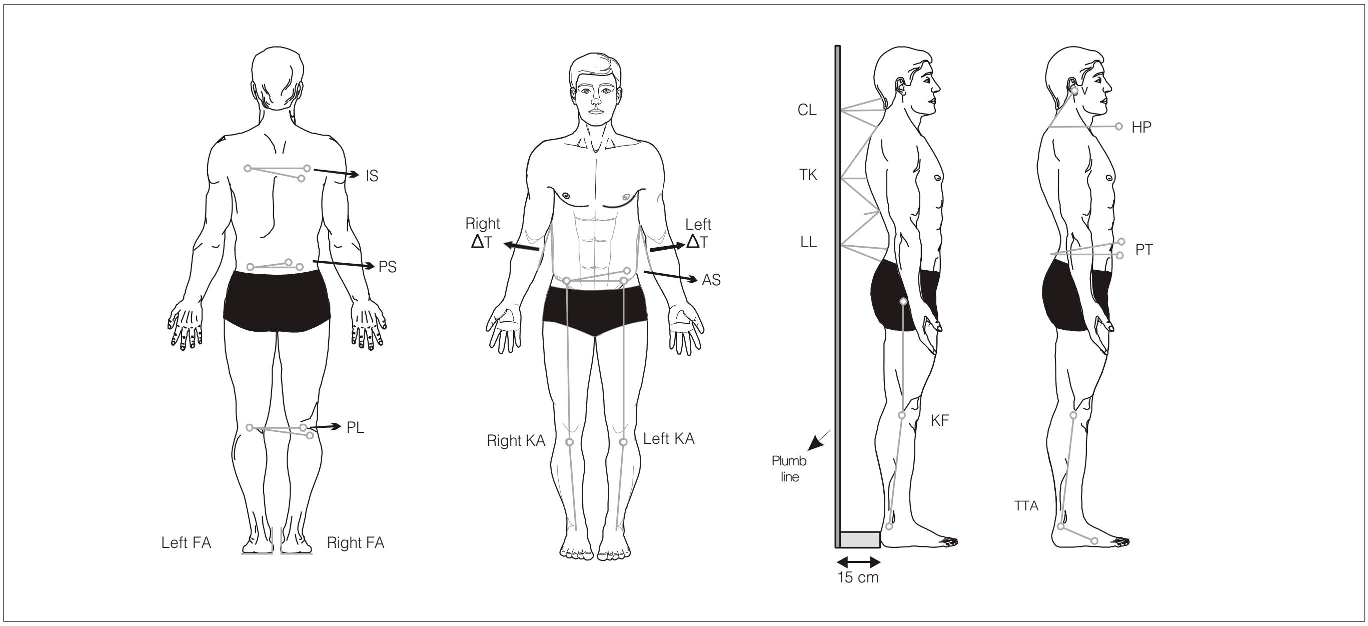


**Figure 1.** Angles evaluated in the posterior, anterior and left view[25]: IS (inferior scapular angle); PS (posterior superior iliac spine angle); PL (popliteal line angle); FA (foot angle); ΔT (Thales triangle); AS (anterior superior iliac spine angle); KA (knee angle); CL (cervical lordosis); TK (thoracic kyphosis); LL (lumbar lordosis); KF (knee flexion); HP (head protrusion); PT (pelvic tilt); TTA (tibiotarsal angle).

PS, PL) were considered symmetrical when the angle values found in the photogrammetry analysis were equal to zero degrees, and asymmetrical when these qualitative angle values were equal to or greater than 0.1 degree. The ΔT angle was qualitatively classified as symmetrical or asymmetrical by comparing the qualitative measure of the right and left sides. The knee angle was classified as normal when the quantitative measure was between 170° and 175°, valgus when this angle was less than 170° or varus when it was greater than 175°[26]. The foot angle was classified as normal when equal to 90°, valgus when greater than 90° or varus when less than 90°. These parameters were set by the authors of this study. The PT angle was considered normal when the value was zero for the angle formed by the intersection of the straight line between the anterior superior iliac spine (ASIS) and the posterior superior iliac spine (PSIS), and a line parallel to the ground. When the PSIS was lower and formed a negative angle, it was considered a posterior pelvic tilt, and when the ASIS was lower and formed a positive angle, it was considered an anterior pelvic tilt[4]. It was not possible to transform the remaining angles in the lateral view (HP, CL, TK, LL) from quantitative to qualitative because there are no normality values established in the literature.

## Visual postural assessment

The symmetry of the following items in the anterior and posterior views was evaluated: eyes, labial commissure, shoulders, clavicle, Thales triangle, ASIS, inferior angles of the scapula, PSIS and popliteal line. Also, the following were evaluated: in the anterior view, the knees (normal, valgus or varus); in the posterior view, foot angle (normal, valgus or varus); in the left lateral view, the position of the head (normal or protruded), lumbar and cervical lordosis (normal, straightened or hyperlordosis), thoracic kyphosis (normal, straightened or hyperkyphosis), position of the pelvis (normal, anterior tilt or posterior tilt), position of the knee (normal, hyperflexion or dislocation).

## Statistical analysis

To analyze the photographs, the examiners considered the presence or absence of changes and the type of change classified according to positive or negative values to indicate the asymmetrical side, i.e. a qualitative analysis. Cramer's V or phi coefficient, an association measure based on the chi-square test, was used to evaluate the agreement between the different examiners of the visual and photogrammetry postural assessments. This coefficient was selected because, to compare both methods, the quantitative photogrammetry data had to be converted into qualitative data. Cramer's V is recommended when the qualitative responses are nominal and do not have a set order of categories[27]. Three groups were considered: (1) agreement between the different examiners of the postural assessment; (2) agreement between the different examiners of the photogrammetry assessment; (3) agreement between the postural and photogrammetry assessments, considering a level of significance of 5% for all the analyses and pointing out non-agreement between findings. The *p* value varies from 0 to 1, and the closer it is to 1, the greater the agreement with the visual postural assessment and with the photogrammetry assessment.

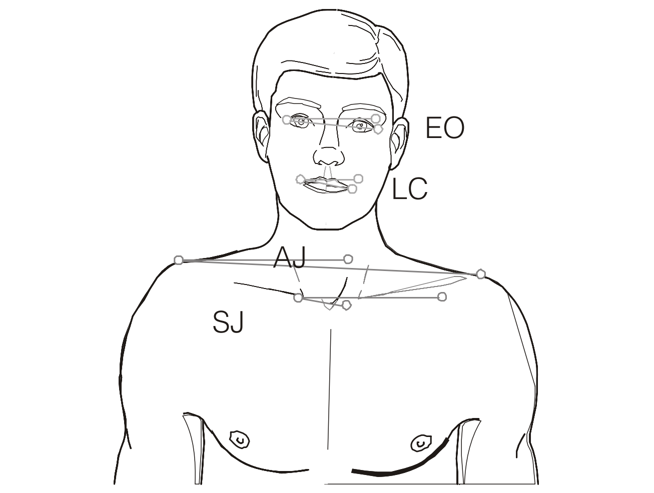


**Figure 2.** Angles evaluated in the facial photographs[5]: EO (external orbicular angle), LC (labial commissure angle), AJ (acromioclavicular joint angle) and SJ (sternoclavicular joint angle).

To determine whether the quantitative results of the photogrammetry corresponded to the detection of symmetries and asymmetries of the visual assessment, the lowest and the highest photogrammetry values were noted down. The same procedure was carried out when the examiner attributed symmetry to a segment.

# Results

The sample consisted of 21 university students with a mean age of 24.19±1.3 years, mean body mass 59.10±12.27 Kg and mean height 1.66±0.05 m.

## Visual postural assessment

When different examiners carried out the visual postural assessment, not all the observations showed agreement on the presence or absence of changes and on the type

**Table 1.** Interobserver agreement for the visual postural assessment and the photogrammetry assessment considering the analysis of all angles obtained for all participants. Data refers to the *p* value associated with Cramer's coefficient.

| Angle | Photogrammetry | Visual postural assessment |
|---|---|---|
| EO | 0.80 | 0.47 |
| LC | 1.00 | 0.00* NA |
| AJ | 0.91 | 0.01* NA |
| SJ | 0.91 | 0.00* NA |
| AS | 1.00 | 0.00* NA |
| ΔT | 0.18 | 0.20 |
| Right KA | 0.93 | 0.57 |
| Left KA | 1.00 | 0.67 |
| IS | 1.00 | 0.00* NA |
| PS | 1.00 | 0.00* NA |
| PL | 0.90 | 0.06 |
| Right FA | 0.35 | 0.23 |
| Left FA | 0.50 | 0.40 |
| PT | 1.00 | 0.18 |

* NA p≤0.05 (no agreement); EO=external orbicular; LC=labial commissure; AJ=acromioclavicular joint; SJ=sternoclavicular joint; AS=anterior superior iliac spine; ΔT=Thales triangle; KA=knee angles; IS=inferior scapular angle; PS=posterior superior iliac spine angle; PL=popliteal line angle; FA=foot angle; PT=pelvic tilt.

**Table 2.** Comparison between photogrammetry and visual assessment for each angle on the anterior view obtained for each participant (*p* value associated with Cramer's coefficient). Results in bold indicate *p* values lower than 5% (no agreement).

| Participant | EO | ΔT | Right KA | Left KA | PL | Right FA | Left FA | PT |
|---|---|---|---|---|---|---|---|---|
| 1 | **0.02** | **0.05** | 0.08 | 0.08 | 0.22 | **0.05** | **0.01** | 0.08 |
| 2 | 0.08 | 0.22 | 0.08 | 0.08 | 0.08 | 0.27 | **0.05** | 1.00 |
| 3 | 0.37 | 0.19 | **0.01** | **0.01** | **0.05** | 0.22 | 0.22 | 1.00 |
| 4 | **0.05** | 0.22 | 0.08 | 0.08 | 0.27 | **0.05** | **0.01** | 0.08 |
| 5 | 0.27 | **0.01** | 1.00 | 1.00 | 0.22 | 0.14 | 0.14 | **0.05** |
| 6 | 1.00 | 0.08 | **0.01** | **0.01** | 0.08 | **0.05** | **0.01** | **0.05** |
| 7 | **0.01** | 0.27 | 0.27 | **0.05** | 0.27 | **0.01** | **0.01** | **0.01** |
| 8 | **0.01** | **0.01** | **0.01** | **0.01** | 1.00 | 0.08 | 0.08 | 0.27 |
| 9 | **0.05** | 0.22 | 1.00 | **0.01** | 0.08 | 0.19 | 0.14 | **0.01** |
| 10 | 0.22 | 0.19 | 0.22 | 0.22 | 1.00 | **0.05** | **0.01** | **0.05** |
| 11 | 0.08 | 0.08 | **0.01** | **0.01** | **0.05** | **0.05** | **0.05** | **0.01** |
| 12 | 0.27 | 0.51 | 0.27 | **0.05** | 0.27 | **0.05** | **0.05** | **0.05** |
| 13 | **0.05** | 0.14 | 0.51 | 0.22 | 0.08 | **0.05** | **0.01** | **0.01** |
| 14 | 1.00 | 1.00 | 0.27 | 0.27 | 0.08 | **0.05** | 0.08 | 1.00 |
| 15 | 0.08 | **0.01** | 0.27 | **0.05** | 0.22 | 0.19 | **0.05** | **0.01** |
| 16 | **0.01** | 0.08 | **0.01** | **0.01** | 0.08 | 0.41 | 0.08 | 0.27 |
| 17 | **0.05** | 0.22 | 0.27 | **0.05** | 0.27 | **0.01** | **0.05** | **0.01** |
| 18 | 0.27 | **0.01** | **0.05** | **0.05** | **0.05** | 0.19 | **0.01** | **0.05** |
| 19 | **0.01** | 0.27 | **0.05** | **0.05** | 0.08 | 0.19 | 0.14 | 0.08 |
| 20 | 1.00 | 0.22 | 1.00 | 1.00 | 0.08 | 0.08 | 0.08 | 1.00 |
| 21 | **0.05** | 0.08 | **0.05** | 0.08 | **0.01** | **0.05** | 0.19 | **0.05** |
| % of agreement | 52.4 | 76.2 | 47.6 | 42.9 | 85.7 | 47.6 | 42.9 | 42.9 |

p≤0.05 (no agreement). EO=external orbicular; ΔT=Thales triangle; KA=knee angles; PL=popliteal line angle; FA=foot angle; PT=pelvic tilt.

of change (Table 1). In the facial observation, only the EO showed agreement between the different examiners (0.47). In the anterior view, only the AS showed no agreement between the three examiners (0.00) and, in the posterior view, only the IS (0.00) and the PS (0.01) did not show agreement. These results show that the face is the region that had the least agreement.

## Postural evaluation through photogrammetry

When different examiners carried out the postural assessment through photogrammetry, there was agreement in all of the body segments qualitatively assessed, as shown in Table 1. Furthermore, the segments that had previously shown no agreement between the three examiners in the visual postural assessment had a high agreement among the examiners in the photogrammetry assessment.

## Comparison between visual and photogrammetry postural assessments

When each segment assessed by both methods was compared for each participant, the data revealed different agreement values (Table 2). This analysis considered only the segments that showed intraobserver agreement in the visual assessment.

In Table 2, few segments had a significant level of agreement between the two methods of postural assessment, including the LP segment, which had disagreeing results for only four participants, i.e. 80.9% had agreeing measures. This good agreement was also obtained from the measurement of the ΔT segment because only five participants had disagreeing results. There was agreement in 76.2% of the measures. While measuring the right KA of eight participants, the results disagreed, i.e. 61.9% of the measures agreed.

The remaining segments had a low level of agreement of approximately 50%. For the EO, the results disagreed in eleven participants; for the right FA, the results disagreed in eleven participants, respectively 52.4% of agreeing measures for the EO and 47.6% of the agreeing measures for the IS. For the left KA, left FA and PT, in twelve participants, there were disagreeing results, i.e. 42.9% of the measures were concordant.

## Comparison between the quantitative photogrammetry assessment and the qualitative visual postural assessment

The results of the quantitative-qualitative comparison show that the angle measurements of the photogrammetry

**Table 3.** Minimum and maximum values (in degrees) obtained by the three examiners using photogrammetry compared to visual assessment. The physical therapist corresponds to the examiner who used visual assessment. Absent values indicate that the physical therapist found no symmetry or asymmetry for that angle in any of the patients.

| Angle | | Physical therapist 1 | Physical therapist 2 | Physical therapist 3 |
|---|---|---|---|---|
| EO | Symmetry | 0.88°-2.78° | 0.76°-2.93° | 0.73°-3.81° |
| | Asymmetry | 0.73°-5.89° | 0.73°-5.89° | 0.76°-5.89° |
| PL | Symmetry | 0.16°-3.42° | 0.16°-3.42° | 0.16°-2.81° |
| | Asymmetry | 0.56°-2.68° | 0.27°-2.81° | 0.27°-3.42° |
| TT | Symmetry | 0.20°-6.58° | 0.42°-6.58° | 0.20°-4.26° |
| | Asymmetry | 0.42°-2.0° | 0.20°-4.26° | 0.42°-6.58° |
| PT | Normal | 2.52°-10.47° | 6.64°-10.42° | 2.52°-10.47° |
| | Posterior Tilt | 0.43°-8.38° | 0.43°-8.38° | 0.43°-8.38° |
| | Anterior Tilt | 0.43°-9.63° | - | 3.42°-9.63° |
| Right KA | Normal | 172.08°-178.27° | 173.45°-176.62° | 173.45°-176.62° |
| | Valgus | 165.30°-177.46° | 165.35°-178.27° | 165.30°-175.97° |
| | Varus | 172.69°-177.52° | 174.35°-177.52° | 174.46°-177.52° |
| Left KA | Normal | 175.55°-177.49° | 175.74°-179.84° | 175.48°-175.84° |
| | Valgus | 175.80°-177.39° | 175.55°-178.59° | 175.55°-177.23° |
| | Varus | 175.48°-179.84° | 175.48°-178.24° | 176.47°-178.24° |
| ΔT | Symmetry | 1.38° | 2.18°-3.94° | 0.25°-3.94° |
| | Asymmetry | 0.25°-9.97° | 0.25°-9.97° | 0.54°-9.97° |
| HP | Normal | 51.50°-60.56° | 53.23°-60.56° | 51.50°-60.56° |
| | Protruding | 47.54°-54.85° | 47.54°-59.16° | 47.54°-59.16° |
| SL | Normal | 44.26°-93.07° | 44.26°-69.75° | 35.50°-82.06° |
| | Straightened | 35.50°-68.73° | 35.50°-93.07° | 44.69°-93.07° |
| | Hyperlordosis | 30.89°-59.42° | 30.89°-66.65° | 30.89°-66.65° |
| TK | Normal | 89.90°-140.02° | 83.28°-140.02° | 101.57°-140.02° |
| | Straightened | 83.28°-128.69° | 89.90°-138.64° | 83.28°-128.69° |
| | Increased | 96.52°-127.62° | 110.33°-122.88° | 96.52°-133.08° |
| LL | Normal | 51.00°-100.87° | 61.51°-100.87° | 53.94°-100.87° |
| | Straightened | 59.21°-100.86° | 59.21°-100.86° | 61.51°-100.80° |
| | Hyperlordosis | 53.21°-89.86° | 51.00°-89.86° | 51.00°-63.07° |

corresponding to the symmetry and asymmetry did not coincide with the observation noted down in the visual evaluation. The low angle values were visually classified as symmetry, and the asymmetries verified visually did not correspond to the high angle values, which reveals inconsistent results (Table 3).

This relationship was not observed in any of the segments analyzed by all the examiners. For the segments HP, CL, TK and LL, it was not possible to compare the visual analysis with that from the photogrammetry because there are no reports in the literature about normality values concerning the position of the head or of the vertebral curvatures.

The agreement between the three examiners of the visual postural assessment was also analyzed in relation to the classification of the vertebral curvatures. Interobserver agreement concerning the classification of the cervical curvature was 38.0%; concerning the curvature of the dorsal kyphosis, 28.6%; concerning lumbar curvature, 19.0%; and concerning the position of the head, 57.0%.

## Discussion

The data obtained in the present study show that assessment through photogrammetry can detect asymmetries more precisely. This method had higher interobserver agreement compared to the visual method of postural assessment. There are few studies in the literature that have tested and confirmed the reliability of photogrammetry for postural assessment[8,12,13]. The results of the present study are in line with these studies[8,12] because they also show that the results of photogrammetry assessments carried out by different examiners had good agreement. Although visual postural assessment is still used in some scientific studies[28-30], the only study found in the literature which tested the reliability of visual postural assessment was that by Fedorak et al.[1] and the authors only evaluated the cervical and lumbar spine. These authors photographed 36 individuals and showed the images to 28 professionals (physical therapists, physiatrists, orthopedists, chiropractors, rheumatologists) who analyzed the cervical and the lumbar lordosis and classified the changes in these curvatures. The results showed poor interobserver agreement. This confirms the results of the present study which indicated disagreement between different participants for several of the segments analyzed in the visual postural assessment.

The comparison between photogrammetry and visual postural assessment showed that the level of agreement between the two evaluative methods was only significant for some segments (PL=85.7% and ΔT=76.2%). For other segments, however, there was low agreement between the two methods (EO=52.4%; left KA and right FA=47.6%; left FA and PT=42.9%). The only study found in the literature which compared photogrammetry and visual assessment was the study by Pereira[11]. Unlike the results of the present study, this author reported agreement between assessments of the shoulders, ASIS, PSIS, popliteal line, knees and feet. Only the scapula had disagreement. This difference in the results may be attributed to methodological differences because Pereira[11] used only one examiner in each type of assessment and carried out the comparison without describing how much agreement was found in each segment. Moreover, the repeatability of the measures of each evaluative method was not assessed. In the present study, no relationship was found between regions with easy visualization and a greater agreement in the assessments. For example, the mouth and the eyes have the same visibility, nevertheless there was greater agreement between the evaluative methods for the mouth (71.4%) compared to the eyes (52.4%).

The assessment of the pelvis in the anterior view had a greater agreement between the two methods than in the posterior view (AS=90.5% and PS=57.1%), probably because the bone prominence of the ASIS is easier to locate than that of the PSIS. As for the PT, its agreement was also lower; however, in practice, the volume of the soft tissues in the gluteal region and the more horizontal position of the sacrum may be misleading in the visual assessment.

The knee alignment in the lateral view and ankle alignment in the posterior view also had little agreement between the two evaluative techniques. This suggests that it is difficult to evaluate these segments in the visual postural assessment. This result does not conform to the findings by Sacco et al.[31], who evaluated the tibiotarsal angle, knee angle as the KA of the present study, rearfoot angle and Q angle. Sacco et al.[31] used two quantitative resources, photogrammetry and goniometry and found similar results between them, except for the Q angle, which the authors attribute to the distance between the points of reference.

The evaluation between the examiners of the visual postural assessment showed that there is more disagreement between the examiners than agreement. Another point analyzed in this study which was not found in the literature was the relationship between what is visually found by the professionals, such as symmetry and asymmetry, and the values that were found in a quantitative assessment. The data show that often what is considered asymmetrical may have low angle values; conversely, high angle values may be visually classified as symmetrical. Thus, it becomes evident that the photogrammetry data is not correlated with the data of the visual postural assessment.

The relationship between the changes found by the physical therapists in the postural assessment in the lateral view and the angles found in the photogrammetry showed that only HP had a correct relationship among the three examiners; all of them classified it as protruding when the angular values were lower than normal. For CL, however, it was expected that, in the case of straightening, the angular values would be greater than normal, and in the case of hyperlordosis, the values would be smaller. This expectation was only correct in the case of hyperlordosis. The same is valid for LL. As for TK, the opposite is observed, i.e. straightening values should be smaller than those of hyperkyphosis. Only examiner 3 made this association for hyperkyphosis. Therefore, the data of the visual and photogrammetry postural assessments cannot be equalized, as there is little agreement between them.

Although visual postural assessment is widely used and taught, it has been demonstrated that the agreement of the data is poor. Conversely, the quantitative postural assessment by means of photogrammetry has been shown to be more precise and to have a greater interobserver agreement[10], i.e. visual postural assessment is useful, but not as a means of assessing results in scientific research.

## Conclusions

The present study showed a greater agreement between different examiners who carried out the postural assessment through the photogrammetry method than between different examiners who carried out the postural assessment through visual observation. The data found in the photogrammetry assessment did not agree with those obtained by means of the visual postural assessment. This suggests that the data must be analyzed separately, given that there are no arguments to sustain the comparison between them. The values of the postural analysis found in the photogrammetry cannot be used as a reference in the visual postural assessment.

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