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Reliability of measurements derived from the palpation method of a software for postural evaluation: does clinical experience matter?

Fidedignidade nas medidas derivadas do método de palpação de um software para avaliação postural: a experiência clínica importa?

Isabella da Silva Almeida[1]
Larissa Pitanga Barreto[1]
Letícia de Souza Andrade[1]
Caio Victor Sousa[1]
Yomara Lima Mota[1]

Abstract – The postural evaluation software (SAPO) has been used as a valuable tool for the analysis of postural alterations, however, such a tool depends on palpation performed by the evaluator. The aim of the present study was to evaluate the inter- and intra-examiner reliability of experienced and inexperienced examiners in measurements derived from the palpation method, and its possible influence on measurements obtained by SAPO. Nine evaluators participated in the study, which were divided into three groups according to experience with respect to palpation (GI: inexperienced group, GSE: semi-experienced group and GE: experienced group). Each evaluator performed the postural analysis of 10 volunteers, which were photographed in orthostatic position, following the SAPO recommendations. The intra-examiner reliability analysis indicated that all three groups had higher, good and moderate mean correlation values for each examiner than low correlations. In the inter-examiner reliability assessment, GE and GSE groups exhibited higher correlation values. The intra-class correlation coefficient, in the single-measure analysis, presented correlation coefficients <0.70 in 9 of the variables analyzed, indicating non-significant correlation. It was concluded that the measures analyzed by SAPO have high intra-examiner reliability. However, regarding inter-examiner reliability, the group composed of inexperienced evaluators presented lower values, suggesting that the experience time may have influenced the inter-examiner reliability regarding postural evaluation.

Key words: Palpation; Photogrammetry; Posture.

Resumo – *O Software de avaliação postural (SAPO) vem sendo utilizado como uma ferramenta valiosa para a análise das alterações posturais, porém tal ferramenta depende da palpação realizada pelo examinador. O objetivo do presente estudo foi avaliar a fidedignidade inter e intraexaminadores experientes e inexperientes nas medidas derivadas do método de palpação, e sua possível influência sobre as medidas obtidas pelo SAPO. Participaram do estudo nove avaliadores, divididos em três grupos de acordo com a experiência com relação a palpação (GI: grupo inexperiente, GSE: grupo semi experiente e GE: grupo experiente). Cada avaliador realizou a análise postural de 10 voluntários, os quais foram fotografados em posição ortostática, seguindo as recomendações do SAPO. A análise da fidedignidade intraexaminadores indicou que os três grupos apresentaram valores de correlação em média mais altos, bons e moderados, do que correlações baixas. Na avaliação da fidedignidade interexaminadores os grupos GE e GSE exibiram valores de correlação mais altos. O coeficiente de correlação intraclasse, na análise de medida única, apresentou índices de correlação <0,70 em 9 das variáveis analisadas, indicando correlação não considerável. Concluiu-se que as medidas analisadas pelo SAPO possuem uma alta fidedignidade intraexaminadores. No entanto, em relação a fidedignidade interexaminadores o grupo composto por examinadores inexperientes com relação a palpação apresentou valores mais baixos, sugerindo que o tempo de experiência dos examinadores pode ter influenciado na fidedignidade interexaminadores da avaliação postural.*

Palavras-chave: *Fotogrametria; Palpação; Postura.*

1 Catholic university of Brasilia. Brasilia DF. Brazil.

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INTRODUCTION

Postural evaluation is a fundamental procedure in the analysis of the alignment of body segments and is considered essential for the diagnosis of postural deviations resulting from musculoskeletal disorders, as well as for clinical and physiotherapeutic treatment[1-4]. Often, postural assessment is based on the analysis of the patient's pathological history, both on the causal factor report and on the behavior of pain, as well as on a visual inspection and palpation of body segments[5,6]. However, despite its clinical applicability, such postural evaluation components may be questioned regarding their accuracy[5,7].

In relation to palpation, one aspect that may generate inconsistency in this measure is the high variability in the identification of the main anatomical points[8]. In fact, Downey et al.[3] reported low reliability in identifying the vertebral level of the lumbar segment through the surface palpation method, since recognition of the anatomic point may be influenced by the examiner's difficulty in acquiring simple anatomical information on the surface to be evaluated [9]. Moreover, the lack of standardization of palpation techniques and the examiner's experience can be considered as important sources of the variability of this measure[9,10].

On the other hand, there is a growing use of computer programs for postural evaluations that aid in decision making during diagnosis and clinical treatment. It is suggested that such programs provide qualitative or quantitative data, with good accuracy, easy processing and interpretation of results[11-13]. The general proposal is that more adequate postural diagnostic or follow-up assessments are obtained through the use of these computer programs, since small changes in the positioning of body segments can be identified[14-17].

One of the computer programs used in postural evaluation routines is the Postural Evaluation Software (SAPO), which provides analysis tools that are used to obtain measurements of positioning, alignment, length and joint angles[15-17]. However, such tools are dependent on the palpation technique, since they use data derived from the recording of images of segments in different planes defined by the examiner[9,18]. By means of palpation, the examiner marks each anatomical point and from the analysis by the software, the values of anatomical measurements are obtained[18].

However, the initial proposal of providing a more accurate postural evaluation may be compromised by the need of the palpation method, given the high variability among examiners, probably due to the lack of standardization of anatomical identification techniques and differences in the experience among examiners. Therefore, the aim of the present study was to evaluate the inter- and intra-examiner reliability of experienced and inexperienced examiners in measurements derived from the palpation method, and its possible influence on measurements obtained by SAPO.

METHODOLOGICAL PROCEDURES

Sample

Nine examiners performed the postural evaluation of 10 volunteers (8 women and 2 men) aged 18-35 years, who met the following inclusion criteria: 1) absence of sequelae or diagnosis of orthopedic, rheumatological, neurological and respiratory diseases; 2) absence of musculoskeletal pathology leading to limiting pain; 3) not being submitted to surgical intervention for at least 3 years prior to the study; 4) no diagnosis of postural or orthostatic hypotension. All received information about the research and signed the Free and Informed Consent Form, and the study was approved by the Institutional Ethics Research Committee of the Catholic University of Brasilia, registry: 024/2011.

Examiners were divided into three groups according to palpation experience: inexperienced (GI), semi-experienced (GSE) and experienced (GE) groups. The GI group was composed of 3 examiners attending the first semester of Physiotherapy, still without experience in relation to the method, the GSE group was composed of 3 students attending the last semester of Physiotherapy, with basic experience in relation to palpation and the GE group was composed of 3 physiotherapists. Each group evaluated the posture of 10 volunteers, on different days, in the afternoon period.

Procedures

Anatomical points were marked in the body of each volunteer by means of specific material (styrofoam balls of 15 mm in diameter), according to the location of the anatomical points predetermined by the SAPO protocol, namely: trago; acromion; antero-superior iliac spine; greater trochanter of the femur; joint line of the knee; upper edge of the patella; tuberosity of the tibia; malleolus; point between the head of the second and third metatarsals; lower border of the scapula; postero-superior iliac spine; calcaneus; calcaneal tendon; posterior midline of the tibia; and the spinous process of the 7th cervical vertebra (C_7) and the 3rd thoracic vertebra (T_3)[18]. Only GI examiners received previous explanation about the anatomical points due to the lack of knowledge about the technique.

In order to perform the marking of the anatomical points and the capture of images, volunteers were asked to remain in the orthostatic position in a relaxed manner in order to obtain posture as natural as possible, so that they were looking forward and maintaining the upper limbs in a 90° elbow flexion parallel to the body. To guarantee the same support base in the photographs, a turntable and a white A4 paper with the outline of the feet drawn with black marker pen were used. The images of volunteers, derived from two postural evaluations of each examiner, were recorded in four planes: anterior, posterior, left lateral and right lateral views.

Images were captured by a 7.2-megapixel Cybershot (Sony DSC-W55) digital camera positioned parallel to the floor on a Nikkon® tripod leveled 1.0 m off the ground and positioned at a distance of 3.0 m to photograph

the volunteer's entire body. Two plumb lines located on each side of the volunteer were used for the calibration of the image on the vertical and horizontal axis. The room was well lit with black walls and allowed for the privacy of volunteers during the photo session. The same examiner performed three scans of each image generated for each volunteer.

Variables analyzed

From the anatomical points marked and scanning of acquired images, the following variables were analyzed: horizontal alignment of the head (AHC_A), horizontal alignment of the acromion (AHA); horizontal alignment of anterior superior iliac spines (AHEIAS); horizontal alignment of tibial tuberosities (AHTT); horizontal asymmetry of the scapula in relation to T_3 (AHET3); horizontal alignment of the head in relation to C_7 right and left side (AHC_{LD} and AHC_{LE}). As angular measures: angle of the two acromion and the two anterior superior iliac spines (ADAEIAS); frontal angle of the right and left lower limb (AFMID and AFMIE); length difference in the lower limbs (DCMI); right Q angle (AQD) and left Q angle (AQE); right leg / hindfoot angle (APRD) and left leg / hindfoot angle (APRE).

Statistical analysis

After verifying data normality (Shapiro-wilk), the inter- and intra-examiner reliability analysis was performed by the Spearman correlation, and for values below 0.40, correlation was considered low, between 0.41 and 0.59, moderate, between 0.60 and 0.79, good and above 0.80, high. The intra-class correlation coefficient (ICC) was also performed to verify if there was concordance among measurements, where ICC below 0.70 was considered not acceptable, between 0.71 and 0.79, acceptable, between 0.80 and 0.89, very good and above 0.90, excellent. Finally, the Bland-Altman[19] analysis was performed for the GE and GI groups to verify the presence or absence of systematic bias in evaluations. The SPSS software (version 22.0 for Windows) was used.

RESULTS

Correlations performed to determine the reliability of analyses of intra-examiner horizontal and angular measurements are shown in table 1.

The percentage values of the high, good, moderate and low correlations obtained by each of the 9 evaluators in the analysis of the horizontal and angular measurements are shown in Figure 1. The intra-examiner correlation shows that the correlation values were on average higher than lower in measurements analyzed for all examiners, except for examiners 1 and 3 in the GI group.

Table 1. Intra-examiner reliability. Correlation between horizontal and angular measurements performed by the same examiner

Measures	GI			GSE			GE		
	EX 1	EX 2	EX 3	EX 4	EX 5	EX 6	EX 7	EX 8	EX 9
AHC_A	0.69	0.56	0.47	0.74	0.74	0.39	0.30	0.30	0.42
AHA	0.87	0.85	0.81	0.88	0.97	0.90	0.88	0.93	0.55
AHEIAS	0.75	0.95	0.31	0.23	0.66	0.04	0.69	0.80	0.88
AHTT	0,31	0.42	-0.33	0.60	0.85	0.53	-0.06	-0.34	0.74
AHET3	0.74	0.56	0.04	0.26	0.86	0.48	-0.19	0.38	-2.28
AHC_{LD}	0.47	0.67	0.62	0.83	0.79	0.91	0.82	0.94	0.94
AHC_{LE}	0.79	0.94	0.64	0.82	0.92	0.96	0.85	0.85	0.97
ADAEIAS	0.85	0.85	0.46	0.85	0.48	0.47	0.85	0.86	0.85
AFMID	0.96	0.90	0.89	0.87	0.94	0.95	0.91	0.91	0.31
AFMIE	0.38	0.83	0.85	0.95	0.96	0.92	0.99	0.81	0.45
DCMI	0.20	0.77	0.37	0.09	0.81	-0.93	0.39	-0.06	0.63
AQD	0.70	0.33	0.25	-1.05	0.75	0.82	0.43	0.68	0.81
AQE	0.53	-0.15	0.52	0.72	0.62	0.53	-0.26	0.52	0.41
APRD	0.26	0.35	0.36	0.70	0.85	-0.04	0.42	0.71	0.56
APRE	0.24	-0.05	0.02	0.74	0.63	0.62	0.70	0.42	-0.19

Note. horizontal alignment of the head (AHC_A), horizontal alignment of the acromion (AHA); horizontal alignment of anterior superior iliac spines (AHEIAS); horizontal alignment of tibial tuberosities (AHTT); horizontal asymmetry of the scapula in relation to T3 (AHET3); horizontal alignment of the head in relation to C7 right and left side (AHC_{LD} and AHC_{LE}). As angular measures: angle of the two acromion and the two anterior superior iliac spines (ADAEIAS); frontal angle of the right and left lower limb (AFMID and AFMIE); length difference in the lower limbs (DCMI); right Q angle (AQD) and left Q angle (AQE); right leg / hindfoot angle (APRD) and left leg / hindfoot angle (APRE).; Examiner (EX).

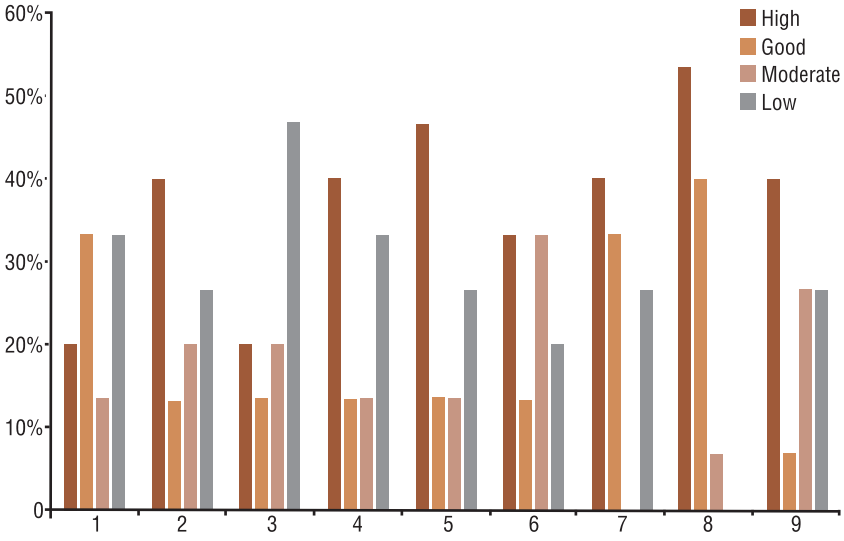

Figure 1. Values of high, good, moderate and low intra-examiner correlations. Examiners 1, 2 and 3 refer to GI; 4, 5 and 6 refer to GSE; 7, 8 and 9 refer to GE.

Correlations performed to determine the reliability of analyses of inter-examiner horizontal and angular measurements are shown in table 2.

Table 2. Inter-examiner reliability. Correlation between horizontal and angular measurements of each group

Measurements	GI	GSE	GE
AHC_A	0.17	0.58	0.50
AHA	0.56	0.61	0.47
AHEIAS	0.17	0.58	0.50
AHTT	0.32	0.37	0.37
AHET3	0.41	0.41	0.35
AHC_{LD}	0.28	0.86	0.76
AHC_{LE}	0.36	0.66	0.84
ADAEIAS	0.18	0.58	0.51
AFMID	0.82	0.93	0.93
AFMIE	0.47	0.91	0.81
DCMI	0.62	0.32	0.36
AQD	0.30	0.25	0.41
AQE	0.16	0.50	0.56
APRD	0.21	0.29	0.42
APRE	0.63	0.55	0.35

Note. horizontal alignment of the head (AHC_A), horizontal alignment of the acromion (AHA); horizontal alignment of anterior superior iliac spines (AHEIAS); horizontal alignment of tibial tuberosities (AHTT); horizontal asymmetry of the scapula in relation to T3 (AHET3); horizontal alignment of the head in relation to C7 right and left side (AHC_{LD} and AHC_{LE}). As angular measures: angle of the two acromion and the two anterior superior iliac spines (ADAEIAS); frontal angle of the right and left lower limb (AFMID and AFMIE); length difference in the lower limbs (DCMI); right Q angle (AQD) and left Q angle (AQE); right leg / hindfoot angle (APRD) and left leg / hindfoot angle (APRE); inexperienced group (GI); semi-experienced group (GSE); experienced group (GE).

The percentage values of the high, moderate and low correlations obtained by each of the 3 groups in the analysis of the horizontal and angular measures are represented in figure 2.

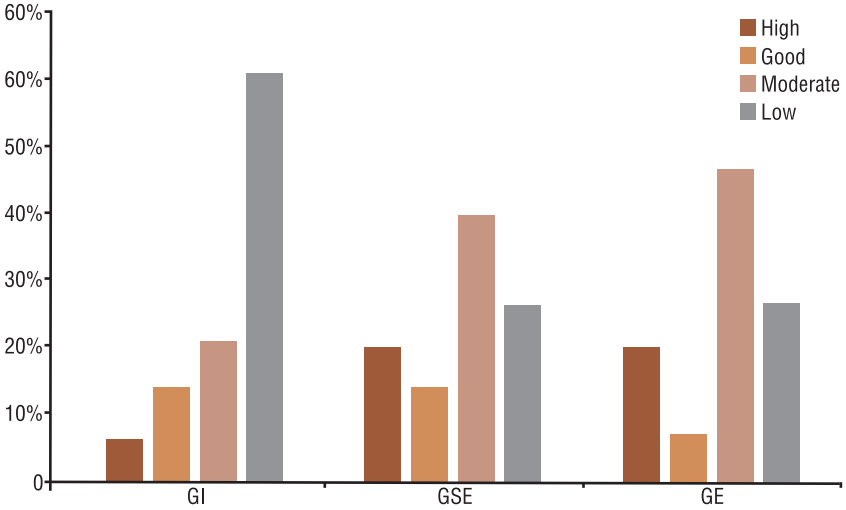

Figure 2. Values of high, moderate and low inter-examiner correlations. Inexperienced group (GI); experienced group (GE); semi-experienced group (GSE).

The intra-class correlation coefficient indexes between groups (GI, GE, GSE) for the horizontal to angular measurements are expressed in table 3.

Table 3. Intra-class correlation coefficient between groups (GI, GSE, GE) for horizontal to angular measurements

	Single measurement	Joint measurement	p-value
AHC_A	0.35	0.61	0.039
AHA	0.90	0.96	<0.001
AHEIAS	0.52	0.76	0.004
AHTT	0.72	0.88	<0.001
AHET3	0.58	0.80	0.002
AHC_{LD}	0.72	0.88	<0.001
AHC_{LE}	0.71	0.88	<0.001
ADAEIAS	0.60	0.81	0.001
AFMID	0.89	0.96	<0.001
AFMIE	0.94	0.97	<0.001
DCMI	0.13	0.31	0.233
AQD	0.40	0.11	0.395
AQE	0.51	0.75	0.005
APRD	0.31	0.58	0.055
APRE	0.64	0.84	<0.001

Note. horizontal alignment of the head (AHC_A), horizontal alignment of the acromion (AHA); horizontal alignment of anterior superior iliac spines (AHEIAS); horizontal alignment of tibial tuberosities (AHTT); horizontal asymmetry of the scapula in relation to T3 (AHET3); horizontal alignment of the head in relation to C7 right and left side (AHC_{LD} and AHC_{LE}). As angular measures: angle of the two acromion and the two anterior superior iliac spines (ADAEIAS); frontal angle of the right and left lower limb (AFMID and AFMIE); length difference in the lower limbs (DCMI); right Q angle (AQD) and left Q angle (AQE); right leg / hindfoot angle (APRD) and left leg / hindfoot angle (APRE). p-value <0.05.

The Bland-Altman analysis was performed to evaluate the concordance between GE and GI groups during evaluations, the limits found were acceptable, i.e., most measurements were distributed within acceptable limits of variation, indicating that evaluations made by experienced and inexperienced examiners tend to produce similar results (data not shown in Tables / Figures).

DISCUSSION

Postural evaluation is a fundamental procedure in the evaluation and follow-up of physiotherapeutic treatment[1-4]. In this field, SAPO software has been used as a tool for the elaboration of more accurate postural evaluation[15-17]. However, despite presenting easy data processing, this tool is dependent on palpation performed by the examiner[9,18]. According to the results obtained, it was verified that the horizontal and angular values evaluated by photogrammetry and analyzed by the SAPO evaluation protocol can be considered reliable, and such results corroborate the results found by other authors[14,20-22], indicating that the software is reliable to measure body segments.

In the present study, nine examiners were analyzed, divided into three groups according to palpation experience. Observing the inter-examiner reliability, GE and GSE groups showed predominance of moderate correlations in measures evaluated, while GI group presented the opposite behavior, exhibiting predominance of low correlations. In relation to

results obtained by the Bland-Altman analysis, it was decided to carry out analysis only between GI and GE groups, once they represent two extremes in relation to experience, and it was possible to observe that most measurements were distributed within acceptable limits of variation, and may indicate that these groups tend to produce similar results. However, when observing ICC, a single measurement, it was possible to verify that nine of the variables exhibited ICC below 0.70, indicating not considerable reliability among the three groups analyzed, and these results may indicate that experience seems to influence the correlation presented, i.e., only basic anatomy and palpation knowledge may not be sufficient to improve reliability.

Like the palpation method, the visual assessment method is highly adopted in clinical practice; however, it appears to exhibit divergent results when the examiner's experience is considered. Moran and Ljubotenski[5], visually analyzing lumbar lordosis, verified that fifth-year students of osteopathy and professionals with five years of experience in the profession produced more reliable results when compared to first-year students of osteopathy, indicating that experience seems to exert influence on the results obtained. In relation to visual evaluation, Fedorak et al.[7] analyzed 28 examiners of different specialties with at least 11 years of average professional practice and concluded that, regardless of clinical practice, intra- and inter-examiner reliability is low. However, Iunes et al.[2] verified that visual posture evaluation presents less concordance when compared to photogrammetry. Due to divergent data, further analyses should be performed regarding the reliability of these instruments and techniques used in clinical practice, as well as related factors, such as the examiner's experience.

Computerized photogrammetry seems to be as reliable as goniometry, another important tool used in clinical practice[14]. However, according to results obtained by Sacco et al.[14], the same behavior was not observed in the Q angle analysis, which showed low reliability, and Glaner et al.[23], using the SAPO software, verified moderate correlation in the analysis of the left Q angle, taking into account the intra-examiner evaluation. Observing data obtained in the present study, the intra-examiner analysis of the left Q angle presented moderate correlations in relation to the inter-examiner reliability of this variable, and palpation experience seems to be determinant for better reliability, since only for the GE group, moderate correlations were found in the analysis of the right and left Q angles. In addition, ICC presented values lower than 0.70 in the single measurement analysis of these variables, and when considering the joint measurement, ICC remained not acceptable for the right Q angle, demonstrating low reliability between groups.

Although the sample of the present study was reduced, the results of Ferreira et al.[15] corroborate the results presented. In the analysis of adult subjects using SAPO, these researchers tested the inter- and intra-examiner reliability and verified that inter-examiner reliability was very good and excellent in 75% of measurements performed by the software and intra-

examiner in 68.3 % of measures. Nery[22] also found good intra- and inter-examiner reliability using the SAPO protocol when analyzing the posture of children, indicating the software as a useful tool to assist professionals in the clinical assessment of different age groups. In the present study, high, good and moderate correlations were found for most examiners; however, it is important to note that examiner 5, belonging to GSE group, did not present low correlations, reinforcing the importance of experience in the palpation method.

CONCLUSION

High intra-examiner reliability was observed in measurements with the SAPO software, especially in examiners with experience in the palpation method. However, in relation to inter-examiner reliability, the group composed of examiners inexperienced in the palpation method presented lower values, suggesting that the examiners' experience may have influenced the inter-rater reliability of the postural evaluation, that is, palpation experience can increase reliability, not only basic knowledge of the technique.

COMPLIANCE WITH ETHICAL STANDARDS

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Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee – Universidade Católica de Brasília and the protocol was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed of the study: ISA, LPB, LSA, YLM. Performed the experiments: LPB, LSA, YLM. Analyzed data: ISA, LPB, LSA, CVS, YLM. Contributed with reagents/materials/analysis tools: ISA, LPB, LSA, YLM. Wrote the paper: ISA, LPB, LSA, CVS, YLM.

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CORRESPONDING AUTHOR

Yomara Lima Mota
Catholic University of Brasilia,
Brasilia, DF, Brazil, Zip postal:
71966-700
Email:Yomara@ucb.br