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The reliability and validity of the Saliba Postural Classification System

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Objectives: To determine the reliability and validity of the Saliba Postural Classification System (SPCS).
Methods: Two physical therapists classified pictures of 100 volunteer participants standing in their habitual posture for inter and intra-tester reliability. For validity, 54 participants stood on a force plate in a habitual and a corrected posture, while a vertical force was applied through the shoulders until the clinician felt a postural give. Data were extracted at the time the give was felt and at a time in the corrected posture that matched the peak vertical ground reaction force (VGRF) in the habitual posture.
Results: Inter-tester reliability demonstrated 75% agreement with a Kappa = 0.64 (95% CI = 0.524–0.756, SE = 0.059). Intra-tester reliability demonstrated 87% agreement with a Kappa = 0.8, (95% CI = 0.702–0.898, SE = 0.05) and 80% agreement with a Kappa = 0.706, (95% CI = 0.594–0818, SE = 0.057). The examiner applied a significantly higher ($p < 0.001$) peak vertical force in the corrected posture prior to a postural give when compared to the habitual posture. Within the corrected posture, the %VGRF was higher when the test was ongoing vs. when a postural give was felt ($p < 0.001$). The %VGRF was not different between the two postures when comparing the peaks ($p = 0.214$).
Discussion: The SPCS has substantial agreement for inter- and intra-tester reliability and is largely a valid postural classification system as determined by the larger vertical forces in the corrected postures. Further studies on the correlation between the SPCS and diagnostic classifications are indicated.

Keywords: Posture, Postural alignment, Postural classification, Postural stability

Introduction

The American Academy of Orthopaedic Surgeons (AAOS) defines good posture as a state of muscular and skeletal balance that protects the structures of the body against injury or progressive deformity allowing for optimum position of the thoracic and abdominal organs.[1] The ability to perform tests and measures of postural alignment has been highlighted as one of the minimum set of required skills for entry-level physical therapists (PT).[2] Orthopaedic manual therapists routinely observe posture as part of the physical therapy examination and evaluation in an effort to determine the presence of deviations from ideal alignment, the presence of muscular imbalances and connections to clinical presentations.[3–7] But despite a general agreement on the need for the examination and rehabilitation of posture, postural assessment remains a varied clinical practice.[2,8] Central to this problem is the absence of a valid and reliable postural assessment or classification tool for the clinical setting.

Americans are leading increasingly sedentary lifestyles contributing to an overall decrease in health and an increase in musculoskeletal pain.[9–12] Investigators have shown that prolonged smartphone usage affects cervical and lumbar spine posture.[13,14] Additional studies have demonstrated that postural alignment affects muscle activity around the spine.[15,16] More than ever, PTs must be able to examine and understand posture and its relationship to musculoskeletal pain and dysfunction. Several investigators concur that postural alignment and musculoskeletal pain and dysfunction are inter-related and state that alignment is a critical component of movement that must be assessed in clinical practice.[3–5] Lewis and Sahrmann[7] recently demonstrated that changes in spinal alignment can affect forces around the hip joint during gait contributing to pain. Van Dillen et al.[17] and Sorensen et al.[18] suggested that changes in spinal alignment can have an effect on low back pain. Dolphens et al.[6] concluded that global postural alignment parameters are associated with low back, neck and thoracic pain. It is important to recognize, however, that while the relationship between posture, function and pain is generally accepted in movement sciences, some studies have also failed to find this relationship.[5,19] The

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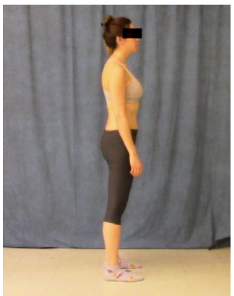
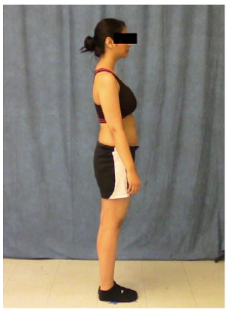
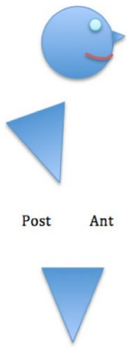
Table 1. Saliba Postural Classification System.

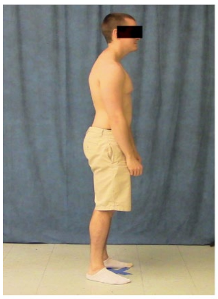
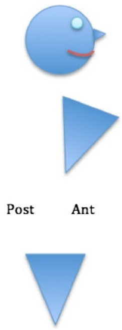
Classification[a]	Description	Picture	Diagram[b,c]	Possible response to a vertically applied force
Vertical/vertical (VV) efficient postural alignment	The thoracic block is vertically aligned over the pelvic block. The angle of the thoracic block is vertical in the sagittal plane allowing for the dome of the diaphragm to rest on top of the abdomen. In this alignment, the vector created by the angle of the xiphoid is perpendicular into the pelvic floor			Vertical force transfers through the musculoskeletal system through the mid-foot and into the standing surface causing no shifts in postural alignment. No postural buckle is felt
Vertical/Posterior (VP)	The thoracic block is vertically aligned over the pelvic block but is posteriorly tipped in the sagittal plane			Vertical force leads to an accentuated extension in the thoracolumbar and lumbar regions with decreased ability to sustain vertical forces
Posterior/Posterior (PP)	The thoracic block is aligned posterior to the pelvic block and is posteriorly tipped in the sagittal plane			Vertical force leads to an accentuated extension in the lower lumbar region with a forward shear of the pelvis and decreased ability to sustain vertical forces
Posterior/Anterior (PA)	The thoracic block is aligned posterior to the pelvic block and is anteriorly tipped in the sagittal plane			Vertical force leads to a slight flexion in the thoracic and lumbar regions with a forward shear of the pelvis and decreased ability to sustain vertical forces

(*continued*)

absence of a standardized and clinically useful postural classification system may contribute to this discrepancy and the absence of conclusive studies in this area.

The use of a valid, reliable and clinically useful measurement tool is essential to a clinician's ability to properly assess posture and the effect of treatment on posture.[8] While motion analysis systems and 3-D posture analysis systems may provide valid and reliable measures of posture, these tools are rarely available in the clinical setting.[8] Postural assessment in the clinical setting is most often performed through a visual analysis of standing and/or sitting postures based on typical posture types commonly labelled in rehabilitation.[3] It is often limited to a static analysis of alignment against an imaginary plumb line or the use of unreliable tools such as goniometric measures and measures of distances between bony landmarks.[8,20]

Table 1. Saliba Postural Classification System.

Classification[a]	Description	Picture	Diagram[b,c]	Possible response to a vertically applied force
Anterior/Posterior (AP)	The thoracic block is aligned anterior to the pelvic block and is posteriorly tipped in the sagittal plane			Vertical force leads to extension in the mid and lower lumbar regions with a posterior shear of the pelvis and decreased ability to sustain vertical forces
Anterior/Anterior (AA)	The thoracic block is aligned anterior to the pelvic block and is anteriorly tipped in the sagittal plane			Vertical force leads to an overall flexion of the trunk and decreased ability to sustain vertical forces

[a]The classification is named based on the vertical position of the thoracic block in relationship to the pelvic block (1st name) and the angulation of the thoracic block in the sagittal plane (2nd word).
[b]The position of the head will vary and is not used in this classification system. The diagram uses a head simply to indicate vertical and a sideview as a point of reference.
[c]The position of the pelvis is not a component of the classification as it may vary although it is depicted in the diagrams as neutral.

Sagittal balance has been described as a posture where a vertical line falls through the centre of mass allowing for horizontal gaze and the maintenance of standing without external support and with minimal muscular effort.[21] Ideal alignment is traditionally described as the sagittal view alignment of a plumb line at prescribed landmarks: posterior to the apex of the coronal suture, through the external meatus, through the odontoid process of the axis, midway through the shoulder, through the bodies of the lumbar vertebrae, through the sacral promontory, posterior to the centre of the hip joint, anterior to the axis of the knee joint, anterior to the lateral malleolus and through the calcaneaocuboid joint.[3] In addition to this ideal alignment, Kendall et al.[3] outlined three static postures that have provided clinicians with a common language for a descriptive assessment of posture: the kyphotic-lordotic, the flat-back and the sway-back postures. These guidelines for postural assessment have provided clinicians with a method and a common language for visually assessing and documenting static posture, however, they do not take into account how posture affects the transfer of forces through the body and the connection between posture and function, an important component of the clinical examination. It is important to note that these guidelines also do not provide information on the position of the thoracic segment or the alignment of the ribcage in relationship to the pelvic girdle. This is an extremely important component of posture as supported by the cylinder model of postural control where the relationship between posture and respiration is described.[22] In this model, efficient intra-thoracic and intra-abdominal pressures (lid and floor for the cylinder of the trunk) are described as necessary for optimal respiration and postural stability.[23]

The Saliba Postural Classification System (SPCS), developed by one of the authors, is a classification system that aims to provide clinicians with an effective and clinically useful tool for assessing posture and its relationship to pain and function. The objective of this initial study was to examine the reliability and validity of the classification system. The SPCS consists of six postural classifications based on the visual examination of the angulation of the thoracic block (thoracic spine, rib cage and sternum) in the sagittal plane and its vertical alignment in relationship to the pelvic block (pelvis, sacrum and coccyx; Table 1). While the SPCS recognizes that the lower extremity and the head/neck are important aspects of posture, it focuses on the trunk as the central component of postural alignment. It defines efficient alignment as one where the centre of mass of the thoracic block is vertically aligned over the centre of mass of the pelvic block,

Figure 1 PT 1 passively positioning a participant in the vertical/vertical SPCS, or the corrected posture, for testing.

Figure 2 PT 2 applying a vertical force through both shoulders to test the participant in the corrected posture.

through a relaxed abdomen, with both segments in a neutral tilt. This alignment is proposed to allow for efficient distribution of vertical forces through the musculoskeletal system thereby supporting pain-free function of the neuromuscular and motor control systems. This classification system was developed from the observation that the position and alignment of the thoracic and pelvic blocks alters the mechanics of weight transference through the system, affecting postural stability and function. Consistent with the cylinder model of postural control,[22,23] this efficient alignment assures that the lid of the abdominal cavity (the thoracic block) is vertically aligned with the bottom of the abdominal cavity (the pelvic block). In addition, the lid is in neutral alignment allowing for proper closure of the abdominal cavity with the intra-abdominal pressure required for activation of the core musculature for efficient postural control.[22,23] The other five postural classes of the SPCS described in Table 1 are considered inefficient with a decreased ability to accept vertical forces through the musculoskeletal system and therefore a decreased ability to properly activate a dynamically stable core for efficient postural control during functional activities.

Methods

Participants

The study was conducted in two phases: reliability and validity. Participants in both phases were healthy male and female volunteers from the local community ranging in age from 18 to 60. Participants were excluded if they had a history of vestibular, neurological or musculoskeletal disorders or injury/surgery within 6 months of the study. The study was approved by the primary author's Institutional Review Board and written informed consent was obtained from all participants prior to participation in the study.

Reliability phase

One hundred volunteer participants were instructed to stand in their habitual posture and were photographed from a side view wearing shorts and a sports bra (females) or only shorts (males). Participants were 45 males and 55 females (mean [SD]; age = 27.69 [6.8] years; height = 170.47 [9.73] cm; weight = 68.57 [14.01] kg).

Validity phase

Fifty-four different participants volunteered for the validity phase. Seven participants were positioned in the same posture for both tests in an effort to further blind the testing PT to the postures being tested. Validity was tested by one's ability to transfer higher forces through the spine and into the lower extremities without any signs of instability or postural give (operationally defined as a shear, a buckling or a rotation at or across a segment or segments). Data were collected as part of a larger study that included the assignment of a subjective test grade to the vertical force applied at the time a postural shear, buckling or rotation was perceived. Subjective data were not analysed in this study. To further improve blinding of the PT assessing the postures, it was decided a priori that seven participants would be tested in the same posture twice and that the results would be excluded from data analysis. As parts of the data analysis required comparisons between the habitual and the corrected postures, it was also decided a priori that participants who received the same score would be excluded from data analysis ($n = 10$). In addition, baseline force plate data from one participant had incomplete data leaving 36 participants for data analysis. Participants were 22 males and 14 females (mean [SD]; age = 28.2 [9.7] years; height = 167.78 [9.60] cm; weight = 67.34 [14.53] kg).

Table 2. Inter-tester and intra-tester reliability for the Saliba Postural Classification System.

	Inter-tester	Intra-tester 1	Intra-tester 2
Rating of agreement[a]	Substantial agreement	Substantial agreement	Substantial agreement
Kappa (*K*)	0.64	0.80	0.71
95% CI	0.52–0.76	0.70–0.89	0.59–0.81
SE	0.06	0.05	0.06
PO (frequency of observed agreement)	75%	87%	80%
PC (frequency of chance agreement)	30%	34%	32%
K_{max}	0.77	0.89	0.87
PABAK (prevalence- and bias-adjusted kappa)	0.50	0.74	0.60
Prevalence Index	VV = 0.59 VP = 0.59 PA = 0.03 PP = 0.35 AA = 0	VV = 0.67 VP = 0.73 PA = 0.01 PP = 0.35	VV = 0.68 VP = 0.56 PA = 0.04 PP = 0.42 AA = 0.78 AP = 0.80
Bias Index	VV = 0.05 VP = 0.14 PA = 0 PP = 0.11 AA = 0.2	VV = 0.03 VP = 0.03 PA = 0.04 PP = 0.04	VV = 0.01 VP = 0.08 PA = 0.05 PP = 0.02 AA = 0.01 AP = 0.01

[a]As defined by Landis and Koch[24]:<0 = less than chance agreement; 0.01–0.20 = slight agreement; 0.21–0.40 = fair agreement; 0.41–0.60 = moderate agreement; 0.61–0.80 = substantial agreement; and 0.81–0.99 = almost perfect agreement.

Procedures/materials/protocol

Reliability phase

Photographs were labelled numerically in the order they were taken. A black bar was added across the participants' faces to block their identity and minimize chances of the PT recognizing a photograph. Classification forms were mailed to two PTs for classification of each participant. Both PTs have used this classification system in clinical practice for over 15 years. Based on a visual analysis of the photograph, each PT classified each participant's posture according to the SPCS. The completed documents were mailed back to the primary investigator for analysis. One week following the initial classification, the PTs completed classification on a second set of the same photographs, arranged in a different and randomly determined order. Upon completion of the second set, the forms were mailed to the primary investigator for analysis. The investigators felt that it was important for reliability of the SPCS to be determined based on an assessment of the same postures, hence the use of still photographs.

Validity phase

Each participant stood on a AMTI OR-6 force-plate (AMTI, Watertown MA, USA) collecting data at 100 Hz with a two-pole, low-pass, 1000 Hz Butterworth filter while a PT (CKC) applied a vertically directed force through both shoulders. Participants were tested while standing in their habitual posture and in a corrected posture. The SPCS efficient posture (Vertical/Vertical) was used as the corrected posture. One PT (VSJ) led the participant to the force plate for testing in their habitual posture or positioned them in a corrected posture through passive re-alignment. Another PT (CKC), blinded to the participant's postural alignment, applied the vertical force (Figures 1 and 2). In order to assure that the PT applying the vertical force was blinded to the posture being tested, the PT (CKC) remained outside the testing room while participants were positioned based on a randomly assigned order of postural alignment for each participant. Privacy screens were used to assure that the testing PT was unable to view the participant's sagittal view while entering the room. A gradually increasing vertical force was applied through both shoulders until the PT felt a shear, a buckle or rotation indicating that the force was no longer transferring vertically through the system. Force plate values in all three planes were extracted at peak vertical ground reaction force (VGRF) for all participants in both postures and at the time point when the VGRF of the corrected posture matched the peak VGRF of the habitual posture.

Statistical analysis

Data analysis was performed using SPSS Version 21 (SPSS, Inc, Chicago, IL, USA) for both the reliability and the validity phases.

Reliability phase

Inter-tester and intra-tester agreement were determined using kappa coefficients (*K*) with 95% CI and SE. Additional information includes frequency of observed agreement (PO), frequency of change agreement (PC), prevalence- and bias-adjusted Kappa (PABAK), maximal attainable Kappa (K_{max}), prevalence index and bias index. Kappa results were interpreted according to Landis and Koch.[24]

Validity phase

Paired *t*-tests were used to test if the total force applied by the PT prior to the posture giving way was higher in the corrected posture when compared to the habitual posture; if the peak VGRF measured as a % of the total force (%VGRF) was different between the corrected posture when compared to the %VGRF in the habitual posture at the time the posture gave way and the test was terminated; and if the %VGRF in the corrected posture was higher when the test was ongoing compared to when the examiner felt a "postural give". Pearson's correlations were used to test if the PT applied greater force when testing heavier participants.

Power analysis

For the validity phase, an a priori sample size calculation was performed using G* Power 3.1.7.[25] With 80% power and 0.05 α level, it was determined that 36 participants were needed to detect a moderate correlation. Fifty-four participants were recruited to account for any possible missing data and technical problems.

Results

Reliability phase

The reliability phase was aimed at establishing inter-rater and intra-rater reliability for the SPCS. Inter-tester and intra-tester agreement were determined using kappa coefficients (Table 2). Substantial agreement was found for inter-tester reliability (Kappa = 0.64) and intra-tester reliability (Kappa = 0.80 and 0.71 for testers 1 and 2, respectively).

Validity phase

The findings of the validity phase were that the PT exerted a greater total force in the corrected posture compared to the habitual posture ($p < 0.001$); the %VGRF was not different between the two postures when comparing the peaks ($p = 0.214$); and within the corrected posture, %VGRF was lower at the end of the test when the examiner felt the "postural give" compared to when the test was ongoing ($p < 0.001$). The examiner exerted greater force when testing heavier participants ($r = 0.72$, $p < 0.001$).

Discussion

The ability to speak the same examination and classification language within a profession has been shown to lead to improved clinical practice, increased collaboration and improved understanding of research results.[26] The need for reliable measures or classification systems has long been established as a requirement for assessing changes and documenting patient progress. Despite the accepted importance of postural assessment and the need for rehabilitation of efficient posture, the various measures of posture currently available and accessible to clinicians have been shown to have poor reliability and validity.[8]

This study comprehensively examined the reliability and several validity aspects of SPCS. The intra-rater and inter-rater reliability of the SPCS, through visual examination of one's standing sagittal posture, was consistently high. This finding has important implications for clinical research and practice as it represents a significant step forward in this field considering the mixed results of previous attempts to create a postural assessment and classification system.[8] The SPCS provides clinicians and researchers with a reliable assessment and classification system for postural alignment and its ability to sustain vertical force requiring no equipment beyond well-trained eyes and hands.

The results on the validity of the SPCS were positive but warrant further research. The authors set out to determine face and construct validity based on the hypothesis that an efficient alignment would allow for greater vertical force translation through the system as measured by the force plate. This is indeed what the results demonstrated thereby supporting the construct and face validity of the classification system. The vertical alignment between the thoracic and the pelvic blocks with the thoracic block in neutral angulation was shown to allow for higher vertical forces to be transferred through the musculoskeletal system prior to the posture giving way, or the clinician perceiving a shear, a buckle or a rotation in response to the increased force travelling through the system. These results demonstrate that the SPCS is a valid measure of postural alignment and efficiency. The results also demonstrate that when the examiner perceived a "postural give", postural efficiency dropped as noted by the lower %VGRF when compared to when the test was ongoing. This is encouraging as it demonstrates that a trained PT can accurately perceive the inefficiency in the postural system, and a postural giving way, as confirmed by the high fidelity measurements of the force plate.

The results also demonstrate that the PT exerted a greater total force in the corrected position suggesting that the alignment of the corrected posture allowed greater forces to be translated to the force plate and that an experienced clinician can perceive when the system can tolerate a greater compression force. While the clinicians involved in this study had several years of experience with the SPCS, the authors believe that the SPCS requires minimal training. The SPCS has been taught for several years in entry-level classroom and continuing education settings. Clinicians, novice and advanced, appear to easily grasp an understanding of this classification system. Nonetheless, further studies are indicated to assess the role of clinical experience on the accuracy of the clinical classification.

The findings did not confirm the hypothesis that the corrected posture would have less dispersion of forces outside the vertical axis when compared to the habitual posture. This may be due to a "ceiling effect" as the vertical component was 98.9 and 98.5% of the total force for the habitual and corrected postures, respectively. It is also possible that the greater dispersion of forces in the habitual posture occurs following the postural break instead of at the time of the break. This possibility was not tested as the force was terminated when the PT felt a postural give. An alternative explanation for these results may be that the participants need acclimatization time in the corrected posture to allow the neuromusculoskeletal system to adjust in the new posture. In addition to examining these explanations, future studies should include patients with postural pathologies to investigate if postural correction truly improves vertical axis force distribution. They should also investigate the efficiency of postural alignment following not only the passive correction into an efficient posture, but also after neuromuscular re-education and motor control training for integration of the new posture into functional activities.

The authors hypothesize that an efficient posture, as described in the SPCS, is necessary for an effective feed-forward mechanism and the proximal stability necessary for improved function and decreased pain. Stability has been described as a requirement for a system to perform its functions with proper load bearing through the spine while allowing for movement and avoiding injury.[27] By evaluating postural stability based on its ability to accept and transfer weight efficiently, the SPCS aims to go beyond posture as a static construct and to correlate postural alignment to efficient, pain free and enhanced function. Grounded upon the inter-relationship between body functions/structures, activity limitations and participation restrictions, the SPCS would appear to provide clinicians with an objective, reliable and valid method for assessing structural alignment that can help direct the plan of care. With the goal of re-establishing one's efficient alignment for function, based on the ability of the system to transfer force, the classification system can direct intervention. The clinician aims to re-establish a neutral angulation of the thoracic block and the vertical alignment of the COM of the thoracic and pelvic blocks. For example, if a patient is classified as a vertical/posterior alignment, the emphasis is the alteration of the angulation of the thoracic block as the COM of both components is already assessed to be vertical. However, if the patient presents with a posterior/posterior alignment, the initial correction must be at the vertical alignment of the blocks prior to correcting the angulation of the thoracic block.

In summary, this study proposed a postural classification system based on the inter-relationship of alignment and position of the thoracic and pelvic blocks. The SPCS is an important addition to the examination of patients in clinical settings. It provides clinicians with a quick and portable method of postural assessment based on the visual observation of the vertical relationship of the thoracic and pelvic blocks and the angulation of the thoracic block in the sagittal plane. The results of this study provide preliminary data supporting the SPCS as a reliable and valid measure of postural alignment as it relates to one's ability to accept vertical force as a measure of dynamic stability within the system. The reliability and validity of the SPCS appear to have been established by this investigation in a population of healthy adults. Future studies on the SPCS should include populations with various pathologies and pain presentations and those with diminished functional activity and participation levels.

Study limitations

In an effort to first determine the reliability and validity of the SPCS, this study was conducted on a sample of convenience of healthy adults limiting its generazibility to other populations. Future studies including participants with a variety of diagnoses are recommended. In the absence of a gold standard for the classification of posture, concurrent validity could not be determined. Lastly, force transducers were not used to determine the amount of force applied by the clinician's hands.

Conclusion

The SPCS appears to have demonstrated adequate intra- and inter-tester reliability and adequate validity providing clinicians with a practical clinical tool for the assessment of posture.

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Notes on contributors

Cristiana K Collins is a faculty with the Institute of Physical Art, which offers professional development courses on Functional Manual Therapy, including concepts of the SPCS.
Vicky S Johnson is the developer of the Saliba Postural Classification System. She was not involved in developing the study design, data analysis and data interpretation. She is also a co-director of the Institute of Physical Art, which offers professional development courses on Functional Manual Therapy, including concepts of the SPCS.

Conflict of interest statement

The authors declare they have no conflict of interest but believe the above information should be disclosed.

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