150 - THE BIOFOTOGRAMETRY EFFICACY TO ANALYZE THE TRUNK FLEXION MOVEMENT OFTHE FLEXTEST

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INTRODUCTION

Flexibility is the capacity of the structures that compose the soft tissue, as muscles, tendons and connective tissues, to prolong through the available amplitude of the articular movement (HERRELSON; LEAVER-DUNN, [2000]).

It is considered as one of the main motor capacities because it presents a direct relation with the realization of the daily life activities, as well as the most complex sportive movements. Moreover, flexibility has been indicated for rehabilitation and it is very important for the general health and physical aptitude.

However, exercises that aim to keep the adequate levels or the improvement of flexibility are always enclosed in the lapsing for any population group. The fact that there are a great variety of protocols, techniques, methods, instruments and devices to test the flexibility, it confirms the relative importance and the use of them in some areas (ARAÚJO, 2005).

The flexibility evaluation can be realized through the Flextest, originally described in 1980, which allows the measure of the flexibility of 20 articulate movements, in an increasing scale of entire numbers from 0 to 4, and the obtainment of a global result is called Flex index (ARAÚJO, 2000). The Flextest is a method that depends a lot on the evaluator observation practice and the joint map.

To quantify flexibility is relatively simple, but to establish accurate values and necessary to amplitude of movements in each joint is still being decided (ACHOUR JÚNIOR, 1995). However, there is a lot to advance in the area of measurement and the amplitude movement evaluation. More specifically, there is a necessity of reference system standardization for the measurement in degrees.

This study uses Computerized Biophotogrametry to evaluate flexibility using as model the modified Flextest aiming to provide to greater results precision.

Material and methods

This is an experimental research, where the same group was evaluated by the Flextest and the kinematics angular Biophotogrametric analysis. The population of this study was composed by 37 children, from 8 to 11 years old, from 8 to 11 years old from 4th and 5th grade of basic level of study, being 26 (70.3%) female and 11 (29.7%) male. All the children had the corporal mass and the stature verified to the IMC determination, making possible a probable interference in the angle results or in the Flextest.

The collect was developed in six stages: (1) patient's card of anamnesis; (2) landmark of the control points; (3) evaluation of the flexibility of the trunk flexion movement through the Flextest; (4) register and selection of the images through photographic camera; (5) procedure for data interpretation; (6) data register.

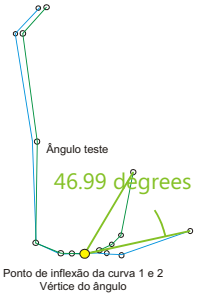
The osseous control points had been demarcated with adhesive, in the white color, with diameter of 0,13mm, for visual orientation at the moment of the mapping and angular photo interpretation of the images. From the lateral sight, it was located eleven markers (Figure 1).

In the evaluation of the flexibility was used the Araújo (2005) definition to the Flextest, being utilized the trunk flexion movement in the protocol. As this, the pertaining to the student must be in the seated position in dorsal decubitus with the legs completely extended and forming a straight angle with the trunk. The hands must be interlaced in the height of the neck. The evaluator must be kneeling in the backwards of the people who will be evaluated, placing the hands in the supine position and under the student's shoulders and from there executing the flexion of the trunk. In case that the individual does not reach the initial position without bending the knees, the punctuation can be zero (0). When just cervical movement is observed, the punctuation is 1, but if there are some movements of the lumbar column, this will start to be at least 3. Therefore, 4 is attributed when it has complete overlapping between trunk and the anterior regions of the thigh.

The images to the Biophotogametry were captured by a digital camera Sony Cyber-Shot mark, 3,2 Mega Pixels to a distance of 2,50 cm on the middle of a mattress in a height of 66cm on a tripod. The position of the student was the same one used for the Flextest analysis. For the interpretation of the images data, it was imported for the CorelDraw®11 program and it was done a profile of the type bind-points for the initial and final position of the movement, called “palito” model or stick-model. Using these data, three procedures were realized.

In procedure 1 (Figure 2), the initial position of the movement was registered, using the angular value (in degrees) of the relation between the portion most mobile of the trunk, in another words, it is between the first point of the trunk "M1" and the point of head "CM". With this, it was possible to exclude the movement of the head in the moment of the test, and this is the point of the vertex[1] for analysis. Also, it was registered the value of the relation between the point in the hip "TM" and the point in the lateral malleolus "ML", in this in case, the vertex of the angle was the point "ELF". Repeating this measure in the next procedure, it was possible to calculate how much the student compensated with the inferior member during the trunk flexion movement. In procedure 2 (Figure 3) it was repeated the same measure, relation trunk-head and movement of the inferior member, however, it was done in the end of the movement. In this procedure, the vertex of the stick-model from which was realized the measure, or, after identify the marker related with the vertex, it could be realized the procedure 3.

When carrying the stick-model to out to the image together with the vertex of the angle and the measures relation trunk-head, it was generated an overlapping of the procedure 1 and procedure 2 for each student, thus it was possible to determinate the inflection point, in another words, the change of inclination of the trunk. So, it was possible to calculate the angle test presented in table 1.



Picture 1- Angle Photo Interpretation of the procedure 3 through the *CorelDrow*® Program.

Table 1- Angular construction for measure of the test angles

Referency	Description
(Vertex of angles)	Referring marker to the curve inflection of the end of test in relation to the beginning
(P1)	Mandibular condyle at the beginning of the test
(P2)	Mandibular condyle at the end of the test

The results of the angular calculation were transcribed to a spread sheet from the Microsoft® Excel 97 and calculated the difference registered for the same angles, between the final and the initial movement.

For the statistics analysis of the data, it was used Box-plot graph. In the descriptive analysis, it was used simple tables, crossed tables, tables of frequencies and descriptive measures, as average, shunting line-standard, medium and quartiles. Also, it was used the dispersion graph. In the inferential analysis, it was used the test "t" of the Student to gauged casks samples and also the index of kappa. Software SPSS v. 7.5 was used to analyze the data.

Results and Discussion

The corporal mass index IMC to the male students is 18,21 ± 2,903 (average ± normal deviation) kg/m² and to the female is 16,13 ± 2,382 (average ± normal deviation) kg/m², being these measures considered normal to the sex and age considered in this study. All the children practice Physical Education in the school and 28 (82,4%) practice it twice a week. Only 6 (17,1%) do not practice Physical Education outside the school.

Table 1- Angle Descriptive Measures towards the examiner

Angle	Examinerá	Examiner â
Initial Head	14,74 ± 2,797[a]	15,06 ± 2,986 [a]
Initial Knee	173,63 ± 7,661[a]	173,31 ± 7,600 [a]
Final Head	81,19 ± 11,931 [a]	82,36 ± 11,587 [a]
Final Knee	160,99 ± 13,205 [a]	161,41 ± 11,576[a]
Difference Knee	12,65 ± 11,221 [a]	11,90 ± 8,591 [a]
Difference Head	66,56 ± 11,588 [a]	67,30 ± 11,532 [a]
Angle Test	53,22 ± 8,117 [a]	56,73 ± 10,841 [b]

According to Table 1, there was not a significant difference ($p < 0,05$) in the initial and final head angles, initial and final knee, difference knee and head between the examiners, however there was a significant difference in the examiners angle test. The angle vertex was chosen through a curve inflexion point of the trunk, after the images superposition of the test 1 and 2, which determinate very subjective choices of the examiners. This factor suggest that the chosen vertex to the angle test must be pre-decided.

Table 2- Cut points (in degrees) to each evaluator and examiner

			25	50	75
Evaluator examiner á	"A"	and			
			46.045	50.05	61.31
Evaluator examiner â	"A"	and			
			48.515	54.26	64.64
AVERAGE			47,28	52,155	62,975

The cut points (numeric intervals) were defined through quartiles, separated from the examiner, according to table 2. So, it is attributed the Biophotogrametry numeric intervals to the trunk flexion movement of the Flextest, which are: 47,28 degrees to the Flextest graduation 1; 52,15 degrees to graduation 2; and 62,97 degrees to graduation 3. The graduation 0 and 4 were not possible to calculate due to the fact they are very rare. The extreme variations of the articular amplitude, such as the hypomobility or the hyper mobility are not commonly found.

This paper demonstrated that the selected positions to the markers make possible the numeric equivalence which defined the referent intervals to the Flextest movement graduation. There was a variability of the statistic results; however, it was possible to compare the visual results with the numeric, measured by the Biophotogrametry, except the Flextest graduation 0 and 4.

Also, this paper defined the cut point to the graduation 1 and 3 of the Flextest, however it is suggested new investigations to contribute to the techniques improvement, including a bigger sample, which involve hypermobility (4) and hypomibility (0) children. Hence, the Biophotogrametry contributes to the trunk flexion movement evaluation and considering the necessity of improvement, it can be used to evaluate others Flextest positions.

Conclusion

It was possible to determinate the cut points to evaluate the trunk flexion movement by the Biophotogrametry through the Flextest.

It is suggested new studied with bigger size sample and inclusion of hypomobility and hypermobility children, as well as to others movements.

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THE BIOFOTOGRAMETRY EFFICACY TO ANALYZE THE TRUNK FLEXION MOVEMENT OFTHE FLEXTEST

Summary

Introduction: The Flextest consists in a method of the maximum passive mobility evaluation of 20 articulate corporal movements and each one of the movements is measured in an increasing and discontinuous scale of entire numbers from 0 to 4, totalizing five possible values, whose analysis is qualitative, the zero (0) characterizes extreme hypomobility and the 4 hypermobility of subjective forms. The flexibility is recognized as one of the main components of the physical aptitude related to the health, however it still has much to advance in the area of measurement and evaluation of the movement amplitude. The kinematics angular analysis, through the processing of the Computerized Biophotogrametry**,** can be used to evaluate the movements of the Flextest. In this paper, it was chosen the trunk flexion movement in the Flextest by Biophotogrametry to express quantitatively the degree of flexibility in this movement, trying to identify values to an angular scale in the process of evaluation for the flextest. Objective: To establish relation among the degrees in the trunk flexion movement in the Flextest, and the measures obtained through the Biophotogrametry angular analysis. Method: participated in the research 37 students with 8 to 11 years old. It was realized through a patient's card of anamnesis, evaluation of the flexibility of the trunk flexion movement through the Flextest, and the captivation of photographic images until the angular photo interpretation. Results: The numerical intervals obtained by the Biophotogrametry for the trunk flexion movement of the Flextest in the group in study were: 47,28 in the Flextest graduation 1; 52,15 to graduation 2; and 62,97 to graduation 3. Graduation 0 and 4 were not possible to calculate due to the fact that they are very rare. Conclusion: it can be concluded that the Biophotogrametry can be used as a resource to evaluate the trunk flexion movement, considering that is necessary to realize some improvement.

Key-words: Flexibility; Flextest; Computerized Biophotogrametry.

L'EFFICACITÉ DE LA BIOPHOTOGRAMMÉTRIE POUR L'ANALYSE DU MOUVEMENT FLEXION DU TRONC DU FLEXITEST

Résumé

Introduction: Le flexitest consiste en une méthode d'évaluation de la mobilité passive maximale de 20 mouvements articulaires corporels, considérant que chacun d'eux est mesuré d'après une échelle croissante et discontinue de nombres entiers de 0 à 4, pour atteindre un total de cinq valeurs possibles, dont l'analyse est qualitative, étant donné que zéro (0) caractérise hypomobilité extrême et quatre (4) hypermobilité de façon subjective. La flexibilité est reconnue comme une des principales composantes de l'aptitude physique par rapport à la santé, mais il y a encore un long chemin à parcourir dans le domaine de la mensuration et évaluation de l'amplitude du mouvement. L'analyse cinématique angulaire, moyennant le traitement de la Biophotogrammétrie par ordinateur, peut être utilisée pour évaluer les mouvements du flexistest. Dans ce travail nous avons choisi le mouvement de flexion du tronc du Flexitest à travers la biophotogrammétrie pour exprimer quantitativement le degré de flexibilité dans ce mouvement, cherchant à identifier des valeurs sur une échelle angulaire dans le processus d'évaluation par le flexitest. *Objectif*: Établir un rapport entre les dégrés du mouvement de flexion du tronc dans le Flexitest et les mesures obtenues par l'analyse angulaire biophotogrammétrique. *Méthode*: Trente sept écoliers âgés de 8 à 11 ans ont participé à la recherche. Une fiche d'anamnèse a été établie, ainsi qu'une évaluation de la flexibilité du mouvement flexion du tronc par le Flexitest, et la captation des images photographiques jusqu'à la photointerprétation angulaire. *Résultats*: Les intervalles numériques obtenus par la Biophotogrammétrie pour le mouvement flexion du tronc du Flexitest dans le group étudié ont été les suivants: 47,28 pour la graduation 1 du Flexitest; 52,15 pour la graduation 2; et 62,97 pour la graduation 3. La graduation 0 et 4 n'ont pas pu être calculées car elles sont assez rares. *Conclusion*: On peut conclure que la Biophotogrammétrie peut être utilisée comme un procédé pour réaliser l'évaluation du mouvement flexion du tronc, considérant qu'il faut effectuer cependant quelques perfectionnements. **Mots cléfs**: Flexibilité; Flexitest; Biophotogrammétrie par ordinateur.

LA EFICACIA DE LA BIOFOTOGRAMETRÍA PARA EL ANÁLISIS DEL MOVIMIENTO FELXIÓN DEL TRONCO DEL FEXITESTE.

Resumen

Introducción: El flexitest consiste en un método de evaluación de la movilidad pasiva máxima de 20 movimientos articulares corporales, siendo que cada uno de ellos se mide en una escala creciente y discontinua de números enteros de 0 a 4, comprendiendo un total de cinco valores posibles, cuyo análisis es cualitativo, siendo que cero (0) caracteriza hipomovilidad extrema y 4 hipermovilidad de forma subjetiva. La flexibilidad es reconocida como un de los principales componentes de la aptitud física relacionada con la salud, pero todavía hay mucho que avanzar en el campo de medición y evaluación de la amplitud de movimiento. El análisis cinemático angular puede ser utilizado para evaluar los movimientos del flexitest mediante el procesamiento de la Biofotogrametría computadorizada. En este trabajo, elegimos el movimiento de flexión del tronco del Flexitest a través de la biofotogrametría para expresar cuantitativamente el grado de flexibilidad en este movimiento, buscando identificar valores para una escala angular en el proceso de evaluación a través del flexitest. *Objetivo*: Establecer una relación entre los grados en el movimiento flexión del tronco en el Flexitest y las medidas obtenidas mediante el análisis angular biofotogramétrico. *Método*: Treinta y siente alumnos con edad entre 8 y 11 años han participado de la investigación. Fue realizada una ficha de anamnesis, además de una evaluación de la flexibilidad del movimiento flexión del tronco a través del Flexitest, y la captación de las imágenes fotográficas hasta la fotointerpretación angular. *Resultados*: Los intervalos numéricos obtenidos mediante Biofotogrametría para el movimiento flexión del tronco del Flexitest en el grupo estudiado fueron: 47,28 para la graduación 1 del Flexitest; 52,15 para la graduación 2; y, 62,97 para la graduación 3. No fue posible calcular las graduaciones 0 y 4 porque son bastante escasas. *Conclusión*: Se puede concluir que la Biofotogrametría puede ser utilizada como un recurso para realizar la evaluación del movimiento flexión del tronco, desde que se operen algunos perfeccionamientos.

Palabras clave: Flexibilidad; Flexitest; Biofotogrametría computadorizada.

A EFICÁCIA DA BIOFOTOGRAMETRIA PARA ANÁLISE DO MOVIMENTO FLEXÃO DO TRONCO DO FLEXITESTE

Resumo

Introdução: O flexiteste consiste em um método de avaliação da mobilidade passiva máxima de 20 movimentos articulares corporais, sendo que cada um dos movimentos é medido em uma escala crescente e descontínua de números inteiros de 0 a 4, perfazendo um total de cinco valores possíveis, cuja análise é qualitativa, sendo que zero (0) caracteriza hipomobilidade extrema e 4 hipermobilidade de forma subjetiva. A flexibilidade é reconhecida como um dos principais componentes da aptidão física relacionada à saúde, porém ainda há muito que avançar na área de medição e avaliação da amplitude de movimento. A análise cinemática angular, através do processamento da Biofotogrametria Computadorizada pode ser utilizada para avaliar os movimentos do flexiteste. Neste trabalho elegemos o movimento de flexão do tronco do Flexiteste pela biofotogrametria para expressar quantitativamente o grau de flexibilidade neste movimento, buscando identificar valores para uma escala angular no processo de avaliação pelo flexiteste. *Objetivo*: Estabelecer relação entre os graus no movimento flexão do tronco no Flexiteste e as medidas obtidas através da análise angular biofotogramétrica. *Método*: Participaram da pesquisa 37 escolares com idade entre 8 a 11 anos. Foi realizada uma ficha de anamnese, avaliação da flexibilidade do movimento flexão do tronco através do Flexiteste, e a captação das imagens fotográficas até a fotointerpretação angular. *Resultados:* Os intervalos numéricos obtidos pela Biofotogrametria para o movimento flexão do tronco do Flexiteste no grupo estudado foram: 47,28 para a graduação 1, 52,15 para a graduação 2 e, 62,97 para a graduação 3. Para as graduações 0 e 4 não foi possível calcular ângulo de corte, por serem bastante raras. Conclusão: Pode-se concluir que a Biofotogrametria pode ser utilizada como um recurso para realizar a avaliação do movimento flexão do tronco, considerando-se a necessidade de alguns aperfeiçoamentos.

Palavras-chave: Flexibilidade; Flexiteste; Biofotogrametria computadorizada.