Evaluation of thoracic kyphosis in older adult women with osteoporosis by means of computerized biophotogrammetry

Avaliação da cifose torácica em mulheres idosas portadoras de osteoporose por meio da biofotogrametria computadorizada

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Abstract

Objectives: To measure and compare the degree of thoracic kyphosis in older adult women with and without spinal osteoporosis, by means of computerized biophotogrammetry. **Methods:** Twelve women of mean age 68.5 years (ranging from 65 to 74 years) were evaluated and divided into two groups. Group 1 consisted of six women with a densitometry diagnosis of spinal osteoporosis (SD: -2.70 to -4.97), while Group 2 consisted of six women with a densitometry diagnosis of spinal osteopenia (SD: -1.07 to -2.09). These groups were compared with young adults. The two groups were photographed in the right sagittal plane with markers attached to the spine at two anatomical points. The images selected were quantified by means of computerized biophotogrammetry, using the software AutoCAD-2006. **Results:** There was a significant difference (p=0.02) between the degrees of thoracic kyphosis in group 1 (66.8°±10.75) and group 2 (53.0°±10.56). **Conclusion:** The results showed that osteoporosis increased the degree of thoracic kyphosis.
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Key words: osteoporosis; kyphosis; photogrammetry.

Resumo

Objetivos: Mensurar e comparar o grau de cifose torácica em mulheres idosas portadoras e não portadoras de osteoporose na coluna por meio da biofotogrametria computadorizada. **Métodos:** Foram avaliadas 12 mulheres com idade média de 68,5 anos (variação de 65 a 74 anos), divididas em dois grupos. O grupo 1, composto por seis mulheres com diagnóstico densitométrico de osteoporose na coluna (DP: -2,70 a -4,97) e o grupo 2, composto por seis mulheres com diagnóstico densitométrico de osteopenia na coluna (DP: 1,07 a -2,09), ambos comparados com a população adulta jovem. Os dois grupos foram fotografados no plano sagital direito com marcadores fixados na coluna em dois pontos anatômicos. As imagens selecionadas foram quantificadas por meio da biofotogrametria computadorizada, utilizando-se o programa Autocad-2006. **Resultados:** Observou-se diferença significativa (p=0,02) entre os graus de cifose torácica do grupo 1 (66,8°±10,75) e do grupo 2 (53,0°±10,56). **Conclusão:** Os resultados permitem concluir que a osteoporose acentua o grau de cifose torácica.
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Palavras-chave: osteoporose; cifose; fotogrametria.

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Introduction ::::.

Aging can be defined as an irreversible process characterized by functional and structural changes to several organs and systems which vary from individual to individual[1]. Among these changes is bone loss which starts in the fourth decade of life and affects both sexes, however with higher intensity in women. During this period of life, the process of bone resorption begins to exceed bone formation, leading to a physiological reduction in bone mass. This intensified imbalance in bone remodeling is called osteoporosis[2]. This study was carried out in order to identify the influence of osteoporosis on the degree of thoracic kyphosis.

Osteoporosis is a bone metabolism disorder which affects mainly women after menopause, and it is characterized by a decrease in bone density and changes in bone structure in a progressive and systemic way, which leads to bone fragility and increased risk of fractures[3]. In Brazil, it is estimated that osteoporosis affects approximately 35% of women over 45 years of age[4]. One of the criteria for an early osteoporosis detection proposed by the World Health Organization (WHO) is the measurement of the bone mineral density (BMD) by means of bone densitometry[5,6], a method capable of measuring the amount of bone (mineral content) in a defined area or defined volumes in absolute values (g/cm^2)[1].

The decrease in the bone density of spinal vertebrae leads to a reduction in the anterior region of the vertebral bodies, which results in compression and collapse of those vertebrae, with a narrowing of discs and intervertebral spaces. These changes can determine a series of spinal deformities and postural modifications, most notably an increase in thoracic kyphosis[7]. Defined as an increase in thoracic spine curvature in the sagittal plane, thoracic kyphosis becomes more pronounced with age and after menopause[8,9].

Radiographic images have been used to measure thoracic kyphosis, however this method has some disadvantages, such as: exposure to radiation; low image quality that impedes analysis and the absence of radiographic equipment in physical therapy clinics for treatment follow-up[9-11]. These limitations motivate the search for non-invasive methods of evaluation of spinal curvatures, including computerized biophotogrammetry[12-16].

According to the American Society of Photogrammetry, computerized biophotogrammetry is "the art, science and technology of reliable information about physical objects and the environment by means of processes of recording, measuring and interpreting photographic images and patterns of radiant electromagnetic energy and other sources"[14]. It is a widely used evaluation instrument for quantifying postural changes through the application of photogrammetric principles to photographic images obtained during body movements. It also complements assessments for physical therapy diagnosis in different areas[17]. The aim of the present study was to measure the degree of thoracic kyphosis in older adult women with and without spinal osteoporosis by means of computerized biophotogrammetry and to verify the difference between the obtained values. The hypothesis is that the highest degree of thoracic kyphosis will be observed in women with osteoporosis.

Methods ::::.

Subjects

Twenty-five women who participated in activities for older adults were evaluated, and twelve of them were selected. The mean age was 68.5 yrs of age (ranging from 65 and 74 yrs). The women also had recently undergone bone densitometry, this being the main inclusion criterion. The subjects were divided into two groups. Group 1 consisted of six women with a densitometry diagnosis of spinal osteoporosis (DP=-2.70 to -4.97), with mean weight 57.5 (±6.9) Kg, mean height 1.4 (±0.07) m and body mass index (BMI) 26.1 (±1.8) Kg/m^2. Group 2 was composed of six women with a densitometry diagnosis of spinal osteopenia (DP=-1.07 to -2.09), with mean weight 62.1 (±9.9) Kg, mean height 1.5 (±0.03) m and BMI 25.3(±3.3) Kg/m^2. Both groups were compared to the young adult population.

Thirteen subjects were excluded from the study because of bone densitometry exam older than 12 months, densitometry diagnosis of spinal osteopenia for the first group, densitometry diagnosis of spinal osteoporosis for the second group or presence of pronounced scoliosis, ankylosing spondylitis, obesity and serious neurological diseases. All subjects received information before taking part in the study and signed a consent form. The project was approved by the Research Ethics Committee of Universidade de Franca (UNIFRAN), protocol number 041/07.

Evaluation of the degree of thoracic kyphosis

Computerized biophotogrammetry was used for a quantitative evaluation of the degree of thoracic kyphosis, following the methodology proposed by Vieira[18]. The photographic records were taken with a HandyCam vision video camera (Sony digital Zoom 460X Optical 20X), positioned parallel to the ground, on an even tripod. The analog images were converted into digital images using a Pinnacle' PCTV video capture board. A well-lit and private room was used to ensure privacy to the subjects.

For the photographic record, the subjects remained in a standing positing in front of a symmetrograph. They were

positioned at a previously marked spot. The camera was positioned at a distance of 2.86 m, and the tripod was placed at a height of 72 cm to capture the entire body. The markers consisted of a 5-cm stem attached to a red cylindrical base (3.5 cm long and 2 cm wide) held by double-sided adhesive tape to the points seen on the sagittal plane. The images were captured by the software PlayTV USB Pro TV v1.18.

To measure the degree of thoracic kyphosis, perpendicular skin markers were placed on the spinous process of the seventh cervical vertebra (C7) and on the 12th thoracic vertebra (T12). All photographic records were taken by a single photographer, and the markers were always positioned by the same examiner who was unaware of the group to which the subjects belonged. The photographic record of these demarcations was then carried out with the subjects on the right sagittal plane, wearing a swimsuit or underwear. The selected digital photographic records were inserted into a specific software (Autocad-2006), and an examiner was trained for the correct use of this software. It allows the examiner to trace two parallel lines between the C7 and T12 markers, and the intersection of lines represented the degree of thoracic kyphosis, which was quantified with high precision (Figure 1).

Statistical analysis

The unilateral t test was used to determine the statistical significance between the obtained angles. The α level considered for the analyses was set at 0.05.

Results ::::.

According to Table 1, the values obtained in the evaluation of the degree of thoracic kyphosis of the women in group 1 were higher (p=0.02) when compared with the values of the women in group 2. The result obtained in the evaluation of the measurement of the mean degree of thoracic kyphosis observed in group 1 was 66.8º and, in the group 2, 53.0º, as demonstrated in Table 1 and Figure 2.

Discussion ::::.

Osteoporosis is a common condition in one-third of white women over 65 years of age and after menopause, and its main complication is fractures of the vertebral body[4], which intensify thoracic kyphosis[19]. Cortet[20] verified that postmenopausal, osteoporotic women with at least one fracture had a significant increase in thoracic kyphosis (63º) compared to the women without osteoporosis (52º), values similar to the ones observed

Figure 1. Quantitative angle measurement represented by the degree of thoracic kyphosis in the sagittal plane using the software Autocad-2006.
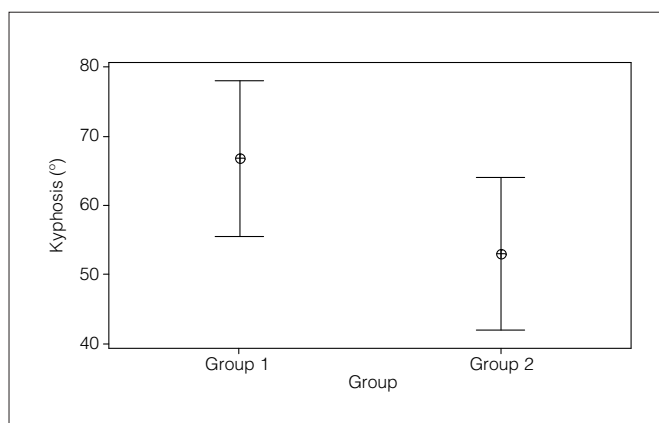
Figure 2. Comparison of kyphosis (°) between evaluated groups. Mean and CI 95%.

Table 1. Values for mean (±SD) age, body mass index (BMI) and degree of thoracic kyphosis of the assessed groups.

	Age	BMI	Kyphosis (degrees)
Group 1	69.1 (2.2)	26.1 (1.8)	66.8 (9.8)
Group 2	68 (2.9)	25.3 (3.3)	53 (9.6)
p-value	-	-	0.02*

* p<0.05.

in the present study. Bartynski et al.[19] studied healthy women over 65 years of age without vertebral fractures and found a smaller mean degree of thoracic kyphosis (43.6º), which demonstrates that osteoporotic women with vertebral fractures have a higher degree of thoracic kyphosis when compared to healthy women of the same age. Itoi and Sinaki[21] stated that healthy, postmenopausal women with a degree of thoracic kyphosis higher than or equal to 34.1º have hyperkyphosis, and they point out that older adult women with osteoporosis have a mean degree of thoracic kyphosis higher than 37.1º. In contrast, Kostuik[22] and Plapler[23] showed that women with a degree of thoracic kyphosis greater than 40º can be considered hyperkyphotic. Granito[24] found a higher mean degree of thoracic kyphosis in women with osteoporosis (54.93º) when compared to women with osteopenia (45.1º).

Radiography is the method used most often to evaluate the degree of thoracic kyphosis (Cobb Angle), and the values of normal thoracic convexity range from 20º to 50º[8,9]. Postural evaluation is essential to planning any physical therapy treatment and its follow-up[13]. Computerized biophotogrammetry has two great advantages in the effectiveness of its clinical application: the low cost of the photo-interpretation system and the precision and reproducibility of the results[25], therefore computerized biophotogrammetry was chosen for those reasons. Granito et al.[7] used this evaluation instrument and observed a mean degree of thoracic kyphosis of 58.19º in older adult women with osteoporosis, which is lower than the one found in the present study.

With age, several changes are identified in the older adult, such as a decrease in the BMD of the vertebral body, intervertebral disc degeneration, reduction in the capacity of the spinal ligaments[26], proprioceptive deficit[24] and weakness of the extensor muscles of the trunk[7,24,27]. These changes account for the presence of thoracic kyphosis in older women without osteoporosis. Older women with osteoporosis show vertebral collapse that leads to postural modifications, including the increase in thoracic kyphosis which contributes to a decrease

in height of approximately 10 to 20 cm[27]. Therefore, the increase in thoracic kyphosis is triggered by aging and exacerbated by osteoporosis[26], which explains the presence of a higher degree of thoracic kyphosis in the evaluated older women with osteoporosis in the present study.

Itoi and Sinaki[21] report a significant negative correlation between the spinal extensor muscles and thoracic kyphosis in healthy, postmenopausal women, which was also demonstrated by Granito et al.[7]. Davini and Nunes[28] state that skeletal muscle mass has a great influence on BMD. Thus, the higher prevalence of osteoporosis in women could be partly explained by lower musculoskeletal mass[29-31].

The influence of physical activity on the prevention and treatment of osteoporosis has been demonstrated in several studies through gain or maintenance of bone mass, increase in muscle strength, flexibility and improvement in coordination and balance, which are important to avoid the risk of falls and consequently fractures[2,24,32]. Physical exercise should always be stimulated in older adults for the prevention and treatment of osteoporosis, as well as the improvement in quality of life, thus reducing the many consequences of aging and osteoporosis, including the increase in thoracic kyphosis.

Conclusion ∷∴.

Based on the present results, it can be concluded that osteoporosis accentuates the degree of thoracic kyphosis. Computerized biophotogrammetry is suggested as a non-invasive option for the quantitative evaluation of the degree of thoracic kyphosis in physical therapy clinical practice.

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