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Quantitative photogrammetric analysis of the Klapp method for treating idiopathic scoliosis

Análise quantitativa do tratamento da escoliose idiopática com o método Klapp por meio da biofotogrametria computadorizada

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Abstract

Introduction: Few studies have proved that physical therapy techniques are efficient in the treatment of scoliosis. **Objective:** To analyze the efficiency of the Klapp method for the treatment of scoliosis, through a quantitative analysis using computerized biophotogrammetry. **Methods:** Sixteen participants of a mean age of 15±2.61 yrs. with idiopathic scoliosis were treated using the Klapp method. To analyze the results from the treatment, they were all of photographed before and after the treatments, following a standardized photographic method. All of the photographs were analyzed quantitatively by the same examiner using the ALCimagem 2000 software. The statistical analyses were performed using the paired *t*-test with a significance level of 5%. **Results:** The treatments showed improvements in the angles which evaluated the symmetry of the shoulders, i.e. the acromioclavicular joint angle (AJ; p=0.00) and sternoclavicular joint angle (SJ; p=0.01). There were also improvements in the angle that evaluated the left Thales triangle (ΔT; p=0.02). Regarding flexibility, there were improvements in the tibiotarsal angle (TTA; p=0.01) and in the hip joint angles (HJA; p=0.00). There were no changes in the vertebral curvatures and nor improvements in head positioning. Only the lumbar curvature, evaluated by the lumbar lordosis angle (LL; p=0.00), changed after the treatments. **Conclusions:** The Klapp method was an efficient therapeutic technique for treating asymmetries of the trunk and improving its flexibility. However, it was not efficient for pelvic asymmetry modifications in head positioning, cervical lordosis or thoracic kyphosis.

Key words: posture; photogrammetry; physical therapy; scoliosis.

Resumo

Introdução: Poucos trabalhos comprovam a eficácia das técnicas fisioterapêuticas para o tratamento da escoliose. **Objetivo:** Analisar a eficácia do Método Klapp no tratamento das escolioses por meio do estudo quantitativo pela biofotogrametria computadorizada**.** **Métodos:** Dezesseis indivíduos com média de idade de 15±2,61 anos, portadores de escoliose idiopática, foram tratados com o método Klapp. Para análise dos resultados do tratamento, todos foram fotografados antes e após o tratamento, seguindo uma padronização fotográfica. Todas as fotografias foram analisadas quantitativamente por um mesmo experimentador, utilizando o software ALCimagem 2000. A análise estatística foi realizada, utilizando-se a o teste-t pareado com nível de significância de 5%. **Resultados:** Os resultados apontam para a melhora após o tratamento dos ângulos agromioclaviculares (AC–p=0,00) e esternoclavicular (EC–p=0,01), que avaliam a simetria dos ombros, e para o ângulo que avalia o triângulo de Tales esquerdo, (ΔTe–p=0,02). Em termos de flexibilidade, houve melhora dos ângulos tibiotársicos (ATT–p=0,01) e coxofemoral (CF–p=0,00). Não houve modificações das curvaturas vertebrais e nem melhora no posicionamento da cabeça, apenas na curvatura lombar, avaliada pelo ângulo lordose lombar (LL–p=0,00), sofreu modificação com o tratamento. **Conclusão:** O método Klapp foi uma técnica terapêutica eficaz para tratar as assimetrias de tronco e a flexibilidade. Não foi eficaz para assimetrias da pelve, modificações da posição da cabeça, da lordose cervical e cifose torácica.

Palavras-Chave: postura; fotogrametria; fisioterapia; escoliose.

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Introduction

Body structures and functions allow all potentialities needed to obtain and sustain good posture. Posture itself can be influenced by incorrect habits, which produce higher levels of tension of supporting structures and also by the occurrence of a body imbalance over its core support, creating postural deviations[1-6].

Scoliosis is a type of postural deviation of the vertebral spine of multiple origins that is characterized by a lateral curvature in the frontal plane associated or not, to vertebral body rotation in the axial and sagittal planes[7-12], and is a significant condition when over 10 degrees of curvature are measured[5,7,9,13-18]. Since its development can occur from an early age and can be aggravated during youth, it has to be managed as early as possible, for after the end of spinal growth the possibility of correcting it becomes less[6,11,15,17,19]. It is also a potentially progressive[9,10] condition; its progression is related to gender, age of onset and degree of curvature, that is, the female gender, the more premature onset and the higher degree of the curvature favor greater progression[12,20,21].

When detected at adolescence, depending on the degree of curvature, the type of conservative treatments chosen is the use of braces that, according to Vasiliadis, Grivas and Gkoltsiou[22], can decrease the quality of life of young individuals. Physical therapy consists in another form of conservative treatment that may or not be associated to the use of braces. However, there is little reproducible references in the literature, regarding physical therapy treatment outcomes related to this pathology[16,19], with little evidence of conservative treatment outcomes[19,23]. Several physical therapy methods are cited for scoliosis treatment, including: Postural Global Reeducation (PGR)[7,16,19], Isostreching[2,11,24], Osteopathy[11], Muscle Chains[25], Pilates[23] and the Klapp method[14,26-28]. Nevertheless, few scientific studies were found that assessed, especially quantitatively, results of these techniques.

Traditionally, clinical diagnoses of scoliosis and follow-up of treatment outcomes have been performed by radiographic examinations which allow quantifying the curvature. However, using radiography exposes the population to radiation effects and involves costs; also, this instrument is not always available for professionals to use[6]. Thus, postural evaluations in which individuals are subjected to non-invasive tests become a viable option for studies of changes in body posture in populations[6,29]. Disadvantages of visual postural assessments include its low reliability and its qualitative use[30]. In this context, computorized biophotogrammetry is one of the quantitative assessment instruments, which allows evaluating the progression of a condition and treatment outcomes, with its reliability being proven in previous studies [29,31].

The Klapp method is an ancient technique has been used in clinical settings even though it is little investigated[13,14,26,27]. It consists of stretching and strengthening the trunk muscles using the cat and kneeling positions that resemble quadrupeds. This method was designed in 1940 by Rudolph Klapp, who observed that quadrupeds did not demonstrate scoliosis, while humans, because of the effects of gravity in the biped position, developed this pathology[14,26-28].

The aim of this research was to analyze the efficacy of the Klapp method for treating scoliosis, through a quantitative analysis using computerized biophotogrammetry.

Methods

Sample

Sixteen patients, three men and 13 women, of the Physical Therapy clinic of the Hospital Universitário Alzira Velano, UNIFENAS, with a mean age, weight and height of 15±2,61 yrs., 48,48±12,36 kg. and 1,58±0,09, respectively, were assessed and treated. Subjects were randomly selected should have had idiopathic scoliosis, and reported a good overall health status. Subjects were excluded when they demonstrated cardiorespiratory or neurological conditions, severe deformities, spine fractures or metal implants, reports of chronic knee pain, or if they were elderly.

All subjects received proper information to participate in the Project and signed a formal consent form according to the 196/96 resolution from the National Health Council (CNS), that was approved by the Ethics and Research Committee involving human beings from the Universidade de Alfenas – UNIFENAS, nº 08/2007.

Subjects's assessments

Initially and at the end of treatments, a photographic recording was made of each subject using a digital camera (*SONY cyber-shot* 5.1 megapixels). All standard methodological care required to use this photography was applied[32], such as: standardization of the position of the subject and of the camera, camera positioning over a level tripod and its placement at all times, parallel to the ground. No zoom was used so distortions would be avoided. All photographs were taken by the same examiner[32].

Whole body records were made in the anterior and posterior frontal planes, and in the sagittal plane with the subject in a straight position and also with forward trunk flexion.

All subjects wore swim suits, and the following anatomic marks were placed bilaterally on the body to serve as reference points to trace assessed angles: sternoclavicular and acromioclavicular joints, anterior superior iliac spine (ASIS), tibial tuberosity, C_4, C_7, T_7, T_{12}, L_3, L_5 spinal processes, inferior angles of the scapula, posterior superior iliac spine (PSIS), greater trochanter, peroneal head, lateral malleolus, and the tuberosity of the distal diaphysis of the fifth metatarsus.

All anatomic marks were traced by the same examiner with white, 0.9 mm diameter self-adhesive tape in the visual points of the anterior and posterior frontal planes, and with plastic cylindric orange rods of 3,5 cm., attached with double-sided tape in the visual points of the sagittal plane. Anatomic marks used in this study were suggested in previous studies[29,31].

Subjects were positioned at 15 cm. from the wall, a fixed distance marked by an ethyl vinyl acetate (EVA) rectangle of 15 cm. of width, 60 cm. of length and 5 cm. thick. Another EVA rectangle of 7,5 cm. wide was positioned between the subjects' feet to keep them in a standartized position. The camera was placed at a 2,4 m. distance from the subject, while the tripod was placed at a height of 1,0 m. from the ground[29].

Techniques perfomed in the treatment of scoliosis

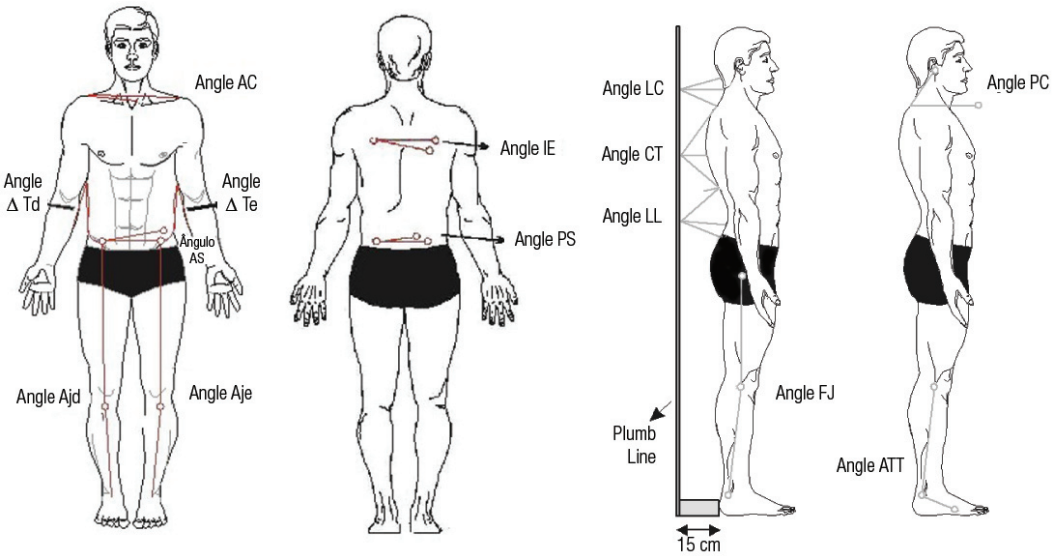
All subjects were treated with the Klapp method, according to this sequence: relaxation, crawling near to the ground, horizontal shifts, side shifts, crawling sidewards, big arches, turning the arm and making a big curve[14,26,27] (Figures 1 and 2).

To perform the relaxation exercises, the subject was positioned in a supine position, with their hips and knees partially flexed and with the palms of their hands on top of the anterior diapgragmatic area. Deep and slow breathing patterns were used so that the subject could decrease tensions and worries.

The rest of the exercises were performed with the subject in the cat and kneeling positions, such as quadrupeds. Verbal commands were used with exact and secure voice rythyms and appropriate volumes in association to constant spinal correction suggestions[26,27].

In the "crawl posture close to the ground" exercise, the subjects was supported over their elbows at 90º, with their fingers and hands in a foward position, sustaining their heads upright, hips and knees at 90º, while doing thoracic hiperkyphosis and lumbar hyperlordosis[14,26,27] (Figure 1).

In the "horizontal sliding" exercise, the subject was in the cat position, with hips and knees at 90º of flexion, and in this position they were requested to extend their trunk and upper limbs foward without touching their elbows on the ground, while simultaneously sustaining their head upright and mantaining the distance between their hands at the width of their shoulders[14,26,27] (Figure 1). After this exercise, the subjects were requested to slide their trunk and upper limbs towards the convex side of the scoliosis, which was the "lateral sliding" exercise[14,26,27] (Figure 1).



AJ=acromioclavicular joint angle; Right ΔT=right Thales triangle; Left ΔT=left Thales triangle; AS=anterior superior iliac spine angle; Right KA=right knee angle; Left KA=left knee angle; IS=inferior scapular angle; PS=posterior superior iliac spine angle; CL=cervical lordosis; TK=thoracic kyphosis; LL=lumbar lordosis; KF=knee flexion; HP=head protrusion; TTA=tibiotarsal angle. Adapted from Iunes et al.[29]

Figure 1. Angles evaluated in the anterior, posterior and right lateral vision.

In the "lateral crawl" exercise, the subjects were placed in a quadruped position, with their hands directed inwardly, bringing the upper limb forward and the lower limb ipsilateral to the concavity backwards, while sustaining the head in rotation towards the convexity[14,26,27] (Figure 2). In the "big arch" exercise the subjects, also in quadruped position, extended their upper and lower limbs ipsilateral to the concavity in a diagonal pattern. Both the ipsilateral knee and elbow were kept close[14,26,27] (Figure 2).

In the following exercise, the "arm turn", the subjects were once again positioned in the cat position, with the upper limb ipsilateral to the concave side in extension and with 90º of abduction, while performing a trunk rotation followed with the head, also towards the concavity[14,26,27] (Figure 2). Finally, in the last exercise, called "big curve", the subject in the cat position, performed an extension of the upper and lower limbs ipsilateral to the concavity[14,26,27] (Figure 2).

Sessions were supervised by the same therapist and were performed in groups, with two groups of five and one with six subjects. Each posture was sustained for eight minutes, in a total therapy time of 70 minutes, twice a week, for 20 sessions. In order for the subject to keep each posture without aid, verbal commands from the therapist were essential to request postural corrections and adequate support.

Posture analyses pre-and post-interventions

All pre- and post-intervention posture photographs were analyzed by the same examiner using the ALCimagem-2000 software. Analysis of the photographs taken in the anterior and posterior frontal planes were performed comparing the symmetry between right and left sides by means of the angles between the sternoclavicular (SC) and acromioclavicular (AJ) joints, anterior and posterior superior iliac spines (AS and PS), tibial tuberosity and inferior angles of the scapula (IS)[29].

For the sagittal plane photograps, taken with the subject in a straight position, a plumb line was traced from the EVA marker that were placed on the ground. Then, lines were traced from C_4, T_7, L_3 points, followed by the analysis of head protrusion (HP), cervical lordosis (CL), thoracic kyphosis (TK), lumbar lordosis (LL), knee flexion (KF) angles, all of which had their reliability tested in a prior study[26]. In this plane, with the subject performing trunk flexion, the following angles were analyzed: hip joint (HJA), formed by the intersections of the straight line that connected the ASIS to the greater trochanter and the straight line that joined the peroneal head to the greater trochanter[29]; Whistance (W), formed by the intersections of the straight line that joined the ASIS to the greater trochanter and the straight line that connected the spinous process of C7 to ASIS[31]; tibialtarsal (TTA), formed by the intersections of the straight line that joined the peroneal head to the lateral malleolus and the straight line from the lateral malleolus to the tuberosity of the distal diaphysis of the fifth metatarsus[29]. Immeadiately after all angles were drawn, the software presented the measurements in degrees. Each measure was repeated three times, and the average was calculated for statistical analysis.

Statistical analyses

Statistical analyses were performed by comparing the quantitative angles analyzed pre- and post-intervention, with values related to twice the standard error of measurement being subtracted from the measures post-intervention as described by Iunes[29]. According to these authors, when positioning the indivudual twice for the quantitative postural analyses, the second measure is different from first one due to errors in positioning and demarcations of the body, even when using all the standards established to photogrammetry analysis. Thus in order to minimize the errors, two times the standard deviation values were subtracted from the post-intervention measures[29]. Only the standard errors from the W and HJA angles were described by Ferreira et al.[24]. Paired *t* tests were performed at a significance level of of 0,05.

1) crawl posture near the ground; 2) horizontal sliding; 3) lateral sliding.

Figure 2. Klapp exercises.

Results

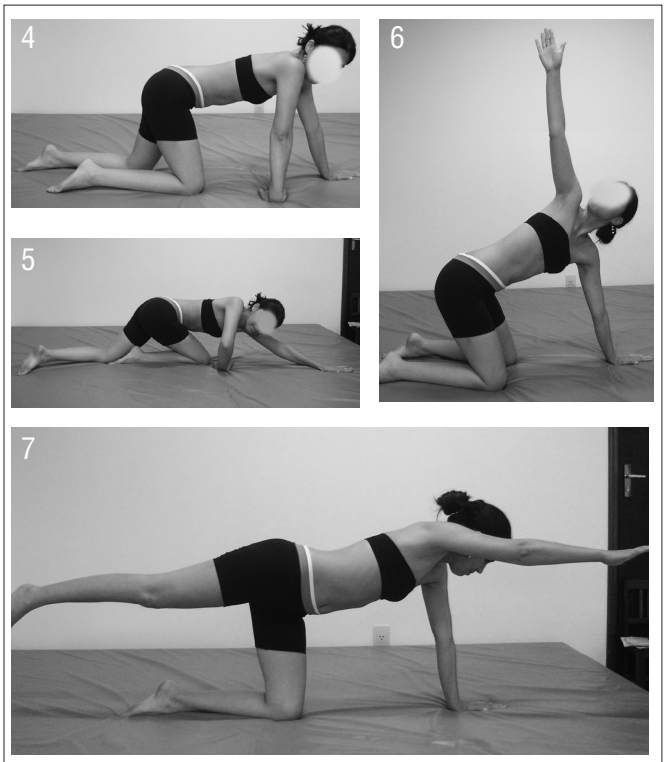
Quantitative results from assessments (pre- and post-intervention) were compared using statistical analysis of the angles measures found in all 16 subjects. The results indicated improvements after treatment, that is, the post-intervention mean values were statistically different in relation to the mean pre-intervention values for the angles acromioclavicular AJ (p=0,00) and sternoclavicular SJ (p=0,01), which assessed shoulders symmetry, and for the left Thales triangle angle (Left ΔT-p=0,02) (Table 1).

ΔlT angles, that measured the left Thales triangle; the anterior and posterior superior iliac spine (AS and PS), that verified the pelvic symmetry, and the inferior angle of scapula (IS-p=0,13) were not statistically modified at post-intervention. In terms of flexibility, significant improvements were observed by means of TTA (p=0,01) and HJA (p=0,00) angles, while no significant improvement was seen on the W angle (p=0,05) in 20 sessions. Regarding the vertebral curvatures assessed by the CL, TK and LL, only the LL angle suffered modification post-intervention (p=0,00), with a trend to its decrease. HP angle was also modified with treatment (p=0,01). For the alingment of the knee in the sagittal plane, assessed by the KF angle, no changes were observed (p=0,29), meaning that the Klapp Method did not affect this aspect; however, changes in alignment were seen for the knees in the anterior frontal plane, as observed by Right KA (p=0,00) and Left KA (p=0,01) angles.

Discussion

Postural changes in children have been increasingly diagnosed at an early age. These changes during the growth spurt are related to innapropriate postures[18], and epidemiological data points for their high prevalence[6]. In a previously described study[5,] 132 children with ages ranging from 7 to 10 were assessed, and significant means of postural changes were found, including scoliosis. The high prevalence of postural changes during the school years was also described by Martelli and Traebert[18], who assessed 344 students from 10 to 16 years old, and by Desth et al.[6], who assessed 495 young people with ages varying from 14 to 18.

One means of studing postural changes is through the use of quantitative postural analysis, in which deviations are numerically quantified[34]. It is important to prove physical therapy techniques' efficacy[18,23], with the quantification of these changes and of the results of these treatments are one of the ways of accomplishing this, even though it is not commonly used in schools and clinical settings in physical therapy[34].



4) lateral crawl; 5) big arch; 6) arm turn; 7) big curve.

Figure 3. Klapp exercises.

Table 1. Mean angular results before (Pre X) and after the treatment (Post X).

Position	Angle	Pre X	Post X	p value
Anterior	AJ	2.29	1.27	0.00*
	SJ	2.60	1.66	0.01*
	AS	2.44	1.82	0.11
	Right ΔT	11.26	10.19	0.05
	Left ΔT	14.00	12.78	0.02*
	Right KA	176.58	175.76	0.01*
	Left KA	175.38	176.29	0.00*
Posterior	IS	3.07	2.36	0.13
	PS	3.30	2.06	0.06
Right lateral	HP	53.31	50.32	0.01*
	CL	32.33	30.78	0.52
	TK	87.36	84.97	0.30
	LL	48.20	39.82	0.00*
	KF	172.50	172.03	0.29
	TTA	131.06	128.60	0.01*
View	W	158.34	153.23	0.05
	HJA	131.76	120.41	0.00*

* p<0.05 t teste; TTA (tibiotarsal angle); AJ=(acromioclavicular joint); Right KA=(right knee angle); Left KA (left knee angle); AS=(anterior superior iliac spine angle); HJA=(hip joint angle); SJ=(sternoclavicular joint angle); IS=(inferior scapular angle); PS=(posterior superior iliac spine angle); Right ΔT=(right Thales triangle); Left ΔT=(left Thales triangle); W, Whistance angle and KF (knee flexion angle).

Scoliosis is a postural deformity that promotes decreased muscular strength of the lumbar extensors in comparison to these muscles in individuals without scoliosis[10]. The Klapp method is a type of treatment in which asymmetrical stretching postures are used and where strenghtening theses muscles is also recommended[14,26,27]. No studies were found regarding this method, except for two graduate papers, in which few patients were assessed with this method, and were evaluated with xray controls[26,27]. In one of these two works, Góis Junior[26] treated three patients using the specified technique in 10, 20 and 30 sessions for each patient, respectivelly. In the radiographic control, it was noted that there were significant improvements in the lumbar curvatures, but no significant results in the thoracic scoliosis. On the other hand, Ribeiro and Ribeiro[27] treated six subjects applying 20 sessions of the Klapp method which resulted in the reduction of the thoracic curvatures, and was also assessed by radiography. They were able to recruit a greater number of subjects and, as was described in previous papers, better results were found for the thoracic asymmetry, as verified by the AJ, SJ and Left ΔT, despite the fact that another technique of quantitative assessment was used (photogrammetry). What is important to consider was that the method used asymmetrical upper and lower limb postures, emphasizing the lengthening of the concave side of the scoliosis, which could in turn, promote improvements of asymmetries.

Considering that most subjects were during their growth spurt, the maintenance of asymmetries of the right ΔT, IS, AS and PS iliac spine could be considered satisfactory, once the observed asymmetries did not evolve.

Previous studies that assessed the outcomes of other techniques employed in the treatment of scoliosis were found. Osteopathy associated with *isostretching* was used by Oliveiras and Souza[11] as the intervention for treating six patients with scoliosis, with results being assessed by photography in a qualitative manner. The authors reported that these techniques were effective in improving anterior, interior, and posterior inspiratory chains of the hip, and also afirmed that an improvement was seen in the asymmetries, even though this was not demonstrated in the results of this study.

Isostretching technique was also applied in another study[2] to treat two patients with scoliosis, with only one of them obtaing a reduction of the curvature observed by radiography; however, both had improvements in thoracic kyphosis. Monte-Raso et al.[24] also selected *isostretching* to treat 12 subjects with postural changes, including among them scoliosis. They concluded that this technique was not effective in treating asymmetries.

Molina[16] used eccentric isotonic strecthing postures to treat nine children from 9 to 15 years old and followed the results by using flexibility tests and radiography. They found that there was a decrease in pain levels and also in the scoliotic curvature, as assessed by the Cobb angle. The same technique was used by Marques[19] to treat the scoliosis of a young woman, with a 10º reduction in the curvature, as assessed by radiography, after 30 sessions.

Rosário et al.[35] compared the use of global strecthing using PGR to passive and self-passive segment stretching of the muscles that form the posterior muscle chain, and observed that the improvements in flexibility of these muscles in individuals without musculoskeletal injuries ocurred with both techniques. Fernández-de-Las-Peñas et al.[36] also observed improvements in flexibility, as assessed by the degree of lumbar flexion, in subjects with ankylosing spondylitis using PGR and segment stretching, as well . However, in a later study by the same authors[7], in which the results of mobility in some patients was assessed at a one year follow-up, better results were seen for long-term mobility in the group of patients who received PGR.

In the present study, the Klapp method was effective in improving the posterior chain, as it was seen on the changes of post-intervention flexibility for the HJA (p=0,00) and TTA (p=0,01) angles. Only the *Whistance* angle did not show significant differences W (p=0,05). These results were not expected, once the technique itself does not work with streching that use postural flexion of the HJ angle, such as *isostretching* e a RPG. Nevertheless, keeping the upper and lower ipsilateral limbs in extension promoted stretching of the muscle chain. In relation to the curvatures, only LL showed significant modifications, with decreased trunk asymmetries associated and with the maintenance of those found in the pelvis.

Another consideration is that in previous studies that used *isostretching,* 30 sessions or more were performed. In this study, using 20 sessions of the Klapp method, decreases in thoracic asymmetry and the maintenance in pelvic asymmetries were noted. More studies are required with this method with a greater number of sessions to verify if pelvic outcomes would improve, or if the technique is more effective for the thoracic spine.

In relation to the head positioning, the results were not satisfactory with this technique because the treatment prediposed to decreases in the angle of protrusion of the HP, it meant that the head showed a trend to go foward, suggesting that perhaps a greater emphasis in the verbal command for head and cervical spine position maintainance was required.

It is suggested for future research the application of the Klapp method with a greater number of sessions and with same time for treatment constraints for better correction of postural compensations. Despite being a method with few

scientific publications, it is used frequently in some clinical settings, since it is feasible to be applied in small groups and it can be an advantageous technique to be used in settings where individualized care cannot be offered due to the volume of patients. However, it is a method that demonstrates application difficulties with elderly or in-patients with knee problems, as kneeling postures are sustained for a prolonged period.

Conclusions

According to the proposed method, it was observed that the Klapp method was a more effective therapeutic technique to treat trunk assymetries in comparison to pelvic ones. Relevant results were obtained regarding the improvement of flexibility lumbar lordosis. For the other spinal curvatures and for the head positioning, Klapp did not show good results, and was also innefective to address the alignment of the knees in the sagittal plane.

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