EFFECTIVENESS OF ABDOMINAL HYPOPRESSIVE TECHNIQUE IN THE TREATMENT OF SPINAL AND PELVIC FLOOR DYSFUNCTIONS: A SYSTEMATIC REVIEW.

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ABSTRACT

Background: Abdominal Hypopressive Technique (AHT), initially indicated for the treatment of pelvic floor disorders, has become widely used in Europe, but there is low quality scientific evidence regarding the effectiveness of this method. **Objective:** The aim of this study was to determine if scientific evidence support the use of AHT in the prevention and treatment of pelvic floor and spine disorders. **Methods:** Studies investigating the effect of AHT in any pathology were searched specifically. Studies reporting AHT alone or AHT included with other techniques were included in the review. **Main results:** Nine studies meeting the inclusion criteria were classified in two groups: the first consisting of pelvic floor dysfunctions (pelvic organ prolapse, prostate cancer, obstetric fistula) studies, and the second one, 3 studies that used AHT in patients with spine dysfunctions (idiopathic scoliosis). From included studies, there were 4 randomized controlled trials, 1 non-randomized clinical trial, 2 cohort studies and 2 cases reports. AHT in pelvic floor dysfunctions showed significant differences compared to control, but no additional effects were seen combined with pelvic floor muscle training. In spinal dysfunctions no significant differences were seen compared to other techniques. **Conclusion:** Although there are some indications that AHT might be used as an adjunctive treatment for pelvic floor dysfunctions, current evidence does not support the use of AHT in the treatment of spine disorders. Further research should be focus on conducting high methodological and interventional quality studies to determine the effectiveness of this method.

Key words: Abdominal hypopressive technique; pelvic floor dysfunctions; urinary incontinence; spine disorders; idiopathic scoliosis.

INTRODUCTION

The Abdominal Hypopressive Technique (AHT) was proposed in the 1980's by Marcel Caufriez, doctor in Motor Function Sciences, for the treatment of pelvic floor disorders (1). This method is aimed to tone up the abdominal, pelvic floor and spine stabilizing muscles (2). It is based on several postural exercises coordinated with a specific breathing rhythm with the aim to decrease intra-abdominal pressure (3). These standards need to be followed to perform the hypopressive abdominals (4,5): axial auto-elongation, chin toward the neck, shoulder joint decoaptation, moving forward of gravity axis, costo-diaphragmatic breathing and an exhalation apnea of 10 to 25 seconds. The basic standing hypopressive abdominal position is shown in Figure 1. These movements bring the abdominal wall to the lumbar spine (posterior and superior movement of the abdominal wall), which leads to a superior displacement of the respiratory diaphragm cupola and supposedly decreases intra-abdominal pressure (1). Caufriez hypothesized that this method affords to relax the diaphragm, decrease intra-abdominal pressure and may activate the abdominal and pelvic floor muscles simultaneously (1). According to Rial and Pinsach (3), an AHT session should last between 20 and 60 minutes and each position repeated three times. As a differentiating trait, the practice of this method does not cause an increase of the intra-abdominal pressure and consequently, does not have negative effects on the pelvic floor musculature (4,6). AHT has become widely used in some European countries. In Spain, this method was introduced in the fitness sector in 2007 (2). Surprisingly nowadays there is not good quality scientific evidence supporting its use and effects.

AHT was conceived to treat and prevent pelvic floor disorders. The pelvic floor muscles (PFM) form the inferior border of the abdomino-pelvic cavity, which is delineated by the

lumbar vertebrae and posterior spinal muscles, the diaphragm, the abdominal wall, and the PFM. PFM activity has been reported simultaneously with the activity of some abdominal muscles, selective activation of the transversus abdominis, or coactivation of the transversus abdominis and the internal oblique muscles (7). Thoracic diaphragm, transversus abdominis, paravertebral muscles and PFM may have a decisive postural role in motor control, which provides dynamic stability to vertebral column and pelvis (8,9).

The increase of intraabdominal pressure in absence of a correct muscular synergy, might compromise the spine and PFM, resulting in different type of hernias (vaginal, abdominal, inguinal, umbilical, discal, etc.) (10). The pressure rise generated in a weak perineum will produce a progressive loss in the pelvic organ holding capacity. This fact could reduce stiffness and the natural support of the PFM, which may trigger dysfunctions related to the urogenital area. A weak abdominal wall is directly related to pelvic floor dysfunctions, pelvic instability, low back pain, etc.

AHT includes exercises affecting different systems; all of them have the common characteristic of producing a decrease in intraabdominal pressure. AHT generates suction to pelvic organs due to diaphragmatic elevation, producing a decrease in ligament tension (11). The intraabdominal pressure decrease, the coactivation of various muscular groups (thoracic diaphragm, transversus abdominis, paravertebral muscles and PFM), and its relation to urogenital dysfunctions and pelvic and column stability, suggest that AHT might represent a way to prevent and treat different pathologies (postural and pelvic floor dysfunctions).

The aim of this review was to determine if current evidence supports the use of AHT as a physical method to prevent and treat pelvic floor and spinal disorders.

METHODS

Search strategy

This review has been developed using indications of *PRISMA Statement*(12), which has helped the authors to improve the reporting of the review. Studies investigating the effect of AHT in any pathology were searched specifically. As a guide, the following question was used: What is the existing evidence of AHT related to different pathologies? Different searches were conducted between December 2015 and March 2016 (last search was conducted on March 29th) using the following databases: Pubmed, PEDro, Scielo, ScienceDirect, Cochrane and Trip Data Base. The keywords entered were: *'Hypopressive', 'Abdominal hypopressive technique', 'Hypopressive abdominal', 'Hypopressive technique', 'Hypopressive exercise', 'Hypopressive method' and 'Hypopressive gymnastics'*. The search was undertaken by two different researchers with the intention of increasing the reliability and certainty of the process. The search was limited to randomised clinical trials (RCT) or reviews published during the period from 2006 to 2016 in English, French, Italian or Spanish languages. In Pubmed the search was limited to RCT and reviews reported in English, French, Italian or Spanish from 2006 till 2016. Two researchers conducted all the phases of the search process independently and disagreements were resolved by discussion.

Inclusion criteria

Studies reporting the use of AHT alone or AHT combined with other techniques in the physical treatment of pelvic floor and spine disorders were included. Study characteristics like sex, age, duration of the intervention and sample size were not considered. Systematic reviews, RCT, non-randomized trials, cohort and cases studies were selected; descriptive studies, congress communication synopsis and expert opinions were excluded. Duplicated studies were excluded. Cited references from selected studies were also retrieved. Selected studies had to meet the following inclusion criteria:

- Design: RCT, systematic reviews, non-randomized trials, cohort and cases studies.

- Year of publication: from 2006 to 2016
- Languages: English, Spanish, French or Italian.
- Full text availability
- AHT intervention in pelvic floor and spine disorders

Methodological quality assessment

Methodological quality of RCT was assessed with two scales: the *Jadad Scale* (13), a score that assesses the methodological quality of clinical trials regarding randomisation, blinding, withdrawals and dropouts; and the *PEDro scale* (14), a checklist that considers two aspects of trial quality, the internal validity of the trial and the statistical information. The rest of studies were evaluated with the *Scottish Intercollegiate Guidelines Network* (SIGN) (15) system to assess levels of evidence and grades of recommendations. The risk of bias of all studies was assessed using the "Risk of bias" assessment tool from the *Cochrane Handbook for Systematic Reviews of Interventions* (16). Two researchers scored each study independently; disagreements were resolved by discussion.

Data extraction

Initially, titles and abstracts of all articles identified by the search strategy were screened against the inclusion criteria independently by both researchers. If it was not clear from the abstract whether the paper might contain relevant data, the full paper was assessed. References cited in full-text articles were also assessed for relevant articles. The authors developed a data-extraction document where the most relevant data were collected (study design, language, year of publication, patients, intervention and control). The full text of the potentially relevant articles were then read and screened against the same criteria to determine the final cohort of included studies. There was complete agreement on study inclusion among the researchers.

RESULTS

Database search

Electronic search identified 34 records, and 2 additional records were identified through other sources (retrieved cited references from selected studies). Fifteen studies were duplicated. From the 21 records screened, 12 studies were not selected because of the following reasons: 4 studies were excluded because the title and/or the abstract did not include AHT in their content, 4 studies were excluded for not meeting the inclusion criteria, 2 studies were excluded because they didn't provide additional data to the review and 2 studies were excluded due to the unavailability of the full text. Finally there were 9 studies included in the review. The *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) (12) process was followed for reporting both included and excluded studies, using the recommended flow chart to show the number of papers identified and included or excluded at each stage (Figure 2). The inter-rater agreement, tested with the Kappa statistic, was excellent (κ= 0.894).

Study characteristics

The selected studies were classified in two groups: the first group included 6 studies using AHT in patients with pelvic floor dysfunctions (pelvic organ prolapse, prostate cancer, obstetric fistula) and the second one included 3 studies of AHT for spine dysfunctions (idiopathic scoliosis). From the 9 included studies, there were 4 RCT, 1 non-randomized clinical trial, 2 cohort studies and 2 cases reports. The methodological quality assessment of studies is described in Table 1. All trials ranged between 1 and 3 of the *Jadad Scale* (13) (Table 2) and between 3 and 6 in the PEDro (14) score (Table 3). The methodological quality of all the studies (RCT and non RCT) ranged between 1+ and 3. The grade of recommendation of the review was considered as grade C. Table 4 summarizes the risk-of-bias assessment.

Abdominal Hypopressive Techniques and pelvic floor dysfunctions

Six studies investigating the effect of AHT in pelvic floor dysfunctions were identified. Participants in the studies of Bernardes *et al.* (17) and Resende *et al.* (18) were women (mean age of 58.8 years) with pelvic organ prolapse (POP) in a stage II; in the studies performed by Castille *et al.* (19,20), patients were women (mean age 36.3 years) with an obstetric fistula which produced urinary incontinence affecting quality of life; and in the studies performed by Serdà *et al.* (21) and Collado *et al.* (22), all patients were men (mean age 71.8 years in the first study, in the second study age was not reported) with prostate cancer in the treatment phase who presented urinary incontinence symptoms. A summary of each study about AHT and pelvic floor dysfunctions is presented in Table 5.

- *Pelvic organ prolapse*

Bernardes *et al.*(17) and Resende *et al.*(18) reported the results of the same RCT in two different publications assessing different outcomes in each publication. Sixty-three patients were randomized in three groups (two intervention groups and one control group). The first intervention group (n= 21) performed pelvic floor muscle training (PFMT), the second group (n= 21) PFMT and AHT, and the third was the control group (n= 21). Five patients dropped out in the control group: 3 due to motivational problems, 1 moved away and 1 underwent a corrective surgery. Bernardes *et al.* (17) reported changes in the cross-sectional area (CSA) of the *levator ani* muscle with transperineal ultrasonography before and after intervention. Results were considered statistically significant when $p < 0.05$. The group that performed PFMT showed an increase of the *levator ani* muscle CSA from 1.65 cm^2 to 2.1 cm^2 ($p < 0.001$), the group that performed PFMT and AHT presented an improvement from 1.43 cm^2 to 1.8 cm^2 ($p= 0.001$), but no significant changes in the control group were observed. The results showed that the CSA of the *levator ani* muscle increased after physiotherapy similarly in both intervention groups compared to control group. The study conducted by Resende *et al.*(18) analyzed changes in pelvic floor muscles function before and after the intervention. The outcomes studied were: pelvic floor strength measured with the maximal

voluntary contraction (MVC) using the Modified Oxford grading system, pelvic floor endurance measured by vaginal palpation and pelvic floor muscle activity measured with surface electromyography equipment. Results were considered statistically significant when $p < 0.05$. Final results showed that both intervention groups presented similar significant increases in pelvic floor strength and floor muscle activity. Final results showed that both intervention groups presented significant increases in all variables.

- *Obstetric fistula*

Castille *et al.*(20) performed a cohort study to determinate the effects of adding a pre- and post-surgery physiotherapy (where AHT was included) and health education program to the surgical intervention in the outcome of surgery for obstetric fistula. Two hundred eleven African women, organized non-randomly in two groups, formed the sample: 112 women formed the intervention group and 99 formed the control group. Four women in the intervention group dropped out for psychological and/or emotional reasons. Both groups were treated with a surgical intervention, and the intervention group also received the pre and post-surgery physiotherapy and health education program. The variables were health-related quality of life (HRQoL) using the Ditrovie scale (a validated scale to evaluate HRQoL of patients with urinary symptoms) and urinary incontinence measured with a Pad Test. The p-value was statistically significant if $p < 0.05$. After the intervention, there were more successful surgeries (68.8%) in the intervention group compared to the control group (57.6% and 35.4% respectively). The results showed that the likelihood of recovery was 1.2 times higher in the intervention group compared to the control group. In women whose fistula was closed after surgery the risk of stress urinary incontinence after surgery was lower in the intervention group compared to the control group ($p < 0.001$). The same author conducted a 1-year follow-up study(19) of the women who received physiotherapy in addition to the surgical intervention. Patients were assessed at 3, 6 and 12 months after hospital discharge, but due to missing data in the 3 and 6 months, the outcome variables were compared at discharge and at 1 year follow-up. The initial group of the follow-up report was composed by

108 women but there were some dropouts; 17 returned to their villages after discharge, 1 died of unknown causes, follow-up data were missing for 2 women and 4 had to repeat the surgery during the follow-up. Finally, 84 women were followed up for 1 year. Results showed that after one year, there were more women with a closed fistula (63.1%) than at hospital discharge (57.1%). There were also fewer women with a failed repair (23.8%) and stress urinary incontinence (10.7%) after 1 year than at hospital discharge (27.4% and 13.1% respectively). Regarding HRQoL, the main score in the Ditrovie scale at hospital discharge was of 38.9 and of 18.5 after 1 year. A score of 10 indicates that the situation is normal and a score of 50 indicates extreme embarrassment. This reduction suggests a significant improvement in HRQoL ($p < 0.001$).

- *Prostate cancer*

Two studies have been performed regarding patients with prostate cancer treated with a program where AHT were included. In 2010, Serdà *et al.*(21) published a report of cases with the aim to share the design and implementation of a progressive rehabilitation program based on strength against endurance exercises adapted to prostate cancer patients in the treatment phase (including prostatectomy, hormone and radiation therapy) with the purpose of reducing the urinary incontinence symptoms and improving HRQoL. The 24-week program consisted of 3 phases: posture re-education (phase 1), PFMT (phase 2) and proprioceptive neuromuscular facilitation exercises and AHT (phase 3). Initially, 36 patients with prostate cancer and experimenting urinary incontinence symptoms composed the work group. Three of them withdrew due to cognitive problems, metastatic bone pain and heart failure, and the final sample was constituted by 33 patients. The variables studied were: anthropometric variables, urinary incontinence variables (intensity, frequency, volume, nocturia), fatigue, pain and HRQoL. The level of significance chosen was $p < 0.05$. Results showed a significant improvement in the anthropometric variables, in the intensity and frequency of the urinary incontinence and in pain intensity. There was also a significant improvement in HRQoL, especially in the patients who experienced a better recovery in

urinary incontinence symptoms. In 2013, Collado *et al.* (22) conducted a randomized control trial in 193 men with localized prostate cancer scheduled for a radical prostatectomy. The study analysed the efficacy of an intensive pre-operatory program based on biofeedback training, AHT and PFMT. There were 5 dropouts (2 for perineal pain, 2 for prostatectomy complications and 1 rejected the treatment). A final sample of 179 men was divided in two groups: Intervention group (n= 87) performed AHT, PFMT and biofeedback training after the surgery; control group (n= 92) received oral instructions about Kegel exercises after surgery. The main outcome variable was the degree of continence assessed with a 24 hour-Pad Test and the International Consultation on Incontinence Modular Questionnaire Short Form (ICIQ-UI SF). Continence improvement was higher in the intervention group compared to the control group, but there were non-significant improvements in the mean 24 hour-Pad Test between both groups.

Abdominal Hypopressive Technique and spinal column dysfunctions

Three studies investigating the effect of AHT in spinal column dysfunctions were found in the search. Characteristics of the studies about AHT and spinal column dysfunctions are shown in table 6. The first study conducted by Caufriez *et al.* in 2006 (6) used a sample of 29 healthy volunteers (72.4% females) divided into two groups: the intervention group (n=15) performed a training based in AHT while the control group (n= 14) performed a postural training based on the same postures that the intervention group but without the muscular activation needed to decrease intra-abdominal pressure. Some patients dropped out of the study but quantity or reasons were not reported. The intervention group showed better improvement in the following variables: spine flexion, isometric endurance of the trunk extensor muscles, spinal arrows and occipital-sacral line. Non-significant differences were found regarding spine side deviation, hamstring and psoas extensibility, spine extension, and ASIS (anterior superior iliac spine) and PSIS (posterior superior iliac spine) height.

The same authors published a report of cases of 3 children with idiopathic scoliosis (mean age 12 years, 66.6% girls) who performed an AHT training program (23). Recently Rami-Colás *et al.* (24) conducted a non-randomized study with a sample of 29 patients with a mean age of 12 years divided in two groups: group 1 (n= 19) received a treatment based on the Schroth method, and group 2 (n=10) performed an AHT-based training program. The Schroth method exercises are designed to reverse all of the abnormal curvatures with a variety of means, based upon the therapist's analysis of a patient's muscle imbalances. One of the primary Schroth tools is strengthening exercises tailored to the individual patient. Another, the rotational breathing technique, focuses on vertebral derotation using the ribs as levers, as well as on increasing the patient's vital capacity (25). To evaluate the intervention, Cobb angle (23,24), spinal rotation (23,24), hunchback (23) and spine lateral deviation (23) were measured. In the non-randomized study (24), results were considered statistically significant if $p < 0.05$. No statistically significant differences were observed between groups in any of the outcome variables in the non-randomized study. It was not possible to present a table showing a summary of the variables analyzed in all the reports because they differ considerably between studies and were not comparable. A summary of the main results reported in each study is shown in Tables 5 and 6.

DISCUSSION

Despite the progressive increase in the use of AHT in the last decade, there is not good quality scientific evidence supporting its use and effects. These exercises were initially conceived to treat and prevent pelvic floor disorders especially after delivery (1). During the search process of this review, studies investigating the effect of AHT in both pelvic floor dysfunctions and spinal disorders, primarily in idiopathic scoliosis, were found.

The review of Armesilla *et al.* (2) with the objective to evaluate the validity of AHT theoretical basis and to present arguments for its practice stated the controversy in some theoretical points: it is not clear whether AHT obtains a postural relaxation of diaphragm, if stimulates

the pneumotaxic center, or if stimulates the expiratory centers and inhibit the inspiratory centers. In the last years some studies have been conducted about AHT and its action mechanisms: Caufriez analyzed the effects of AHT in different physical environments and studied intra-abdominal pressure (26). Stupp *et al.* (27) conducted a study where PFM was assessed during AHT. The few publications investigating the effectiveness of AHT related to pathologies have been included in the present review: just three studies (6,23,24) have been performed where AHT is the intervention by itself.

Given the limited available evidence regarding the use of AHT, authors of this review have had to include low quality level studies. For this reason, the methodological quality has been carefully assessed, and despite the low quality level of the articles, the studies have been analyzed and discussed taking into account all their limitations and risks of bias. Most included articles were assessed as unclear or high risk of bias for most of the methodological domains, and the overall quality of evidence was rated as low. Some of the studies did not describe properly their randomization method so it complicates their reproducibility, and some of them did not have a control group to compare the results. Only three articles (6,23,24) studied the effect of AHT as a unique intervention, the other five studies (17-22) analyzed the effect of a protocol where AHT was included with other techniques so in this cases it was impossible to conclude that the obtained results were consequence of the AHT. Besides, most of the studies did not describe how to perform the exercises, a common trait in physiotherapy trials. Finally, as there was a lack of coincidence among the variables of each study it has not been possible to compare the results and to obtain meaningful data.

Abdominal Hypopressive Technique and pelvic floor dysfunctions

To date more than 50 RCT have demonstrated the effect of PFMT in the treatment of pelvic floor disorders, especially in UI, and it is recommended as first line treatment for UI in women (28,29). It has a level A evidence to treat stress and mixed UI (28,30,31). However,

the PFMT protocols used in the many published RCT's vary widely (32). Nowadays the optimal method to achieve continence via PFMT is not known (33). Recently, a new model involving training of the deep abdominal muscles, in particular the *transversus abdominis*, has been introduced (29,34). As the creator of AHT stated, this technique might be useful to treat pelvic floor dysfunctions, but these theories have to be tested in high quality RCT to show a positive effect and to prove their clinical relevance.

Regarding pelvic organ prolapse, there is little evidence that PFMT can improve this dysfunction and its symptoms (35-37). Caufriez affirms that AHT could be a new model to treat POP (1). The study developed by Bernardes *et al.* (17) and Resende *et al.* (18) aims to compare the effect of AHT and PFMT in women with POP. The results showed that both methods have similar effects on pelvic floor muscle function and that adding AHT to PFMT has no additional effects in muscular strength. The authors assume that a better function and strength of the pelvic floor muscles would improve POP. Most of skeletal muscle groups are composed by a combination of two types of fibers depending on the muscular group, genetics and the use of the muscle: slow fibers or type I (slow speed contraction, high resistance to fatigue, aimed at muscular endurance) and fast fibers or type II (fast speed contraction, fatigable, aimed at muscular strength) (38). Pelvic floor muscles mainly contain slow fibers (type I), which are essential to support intraabdominal organs(39). Caufriez (4) claims that the therapeutic mechanism of AHT should be based on the tonification of type I fibers, not type II. Nevertheless, the classic perineum reeducation programs (PFMT) are based on the tonification of type II fibers (40). These studies (17,18) assessed the pelvic floor muscle strength (responsibility of type II fibers), despite that strength was not specifically approached. The authors propose to assess AHT with other outcome variables. This fact could explain why the studies comparing AHT and PFMT (17,18) have not found evidence that AHT does not add any benefits in muscle strength. Still, the role of AHT in the treatment of POP is not clear and more rigorous research is needed to prove these concepts.

Bo *et al.* (32) state that there is strong evidence supporting effectiveness of PFMT for the treatment of urinary incontinence and that should be performed with the focus on strengthening the PFM. On the contrary, Caufriez (41) asserts that strength is not the only factor to consider in urinary incontinence and consequently it is not priority to perform exclusively strength exercises, yet the myotatic reflex should be reactivated. Another author (29) suggested a new approach that emphasizes the coordination of the diaphragm, deep abdominal muscles and PFM, rather than the strengthening of theses muscles independently. There is evidence that a co-contraction of the *transversus abdominis* occurs during PFM contraction. This synergy may be lost or weakened in patients with symptoms of pelvic floor dysfunctions (32). Caufriez (1) also states that one function of the abdominal sash is to obtain a respiratory synergy with the diaphragm, which are considered tonic functions. Hence he proposes a tonic method to train the deep abdominal muscles via reflex contraction. Another author also affirms that there is the possibility to train the abdominal sash without a voluntary contraction (42). But to date, there are no RCT evaluating whether the specific training of *transversus abdominis* can improve urinary incontinence, change anatomy or improve PFM function (32).

Other studies of AHT in patients with obstetric fistula (19,20) and prostate cancer (21,22), where the main outcome was urinary incontinence, AHT was used in combination with other technique; so that results cannot be attributed exclusively to AHT. Despite, the studies of Castille *et al.* (19,20) conclude that the effectiveness of physiotherapy in this situation is well established, it is not possible to conclude that the obtained results are consequence of the AHT because the intervention consists in a program where AHT were included in combination with other intervention. In this case, the aim of the physiotherapy was to achieve a management of abdominal pressure. As some authors (1,10) have suggested, AHT could be useful to achieve this objective. Special attention should be paid to the fact that the prevalence of an obstetric fistula is almost zero in industrialized countries but, in low-income countries, it is still a very common public health problem; consequently its

results cannot be extrapolated to the population of industrialized countries. Neither of the results described in studies conducted in patients with prostate cancer can be considered as a consequence of AHT because of the same reason (22). Even so, they conclude that physiotherapy improves urinary incontinence symptoms, but the role of AHT by itself cannot be determined. In these studies (19–22), where urinary incontinence was assessed, a special attention is paid to HRQoL, concluding that there is a direct relationship between improvements in urinary incontinence and a better HRQoL.

Abdominal Hypopressive Technique and spinal column dysfunctions

Despite that efficacy of AHT in pelvic floor dysfunctions was evaluated (1), two studies about AHT in spinal column dysfunctions (idiopathic scoliosis) were found (23,24). Previous studies (43) showed that in patients without low back pain, the *transversus abdominis* was recruited before the deltoid muscle in an arm lifting tasks aimed to destabilize the spine. In contrast, the *transversus abdominis* was recruited after the deltoid in patients with low back pain. This finding suggests that the *transversus abdominis* controls spinal motion during destabilizing tasks in healthy conditions; so that, it can be considered as a stabilizing muscle. According to Caufriez (1), the *transversus abdominis* is composed by 75% of type I fibers; its function is to hold internal organs and to obtain a respiratory synergy with the diaphragm. As mentioned before, Caufriez (4) claims that the therapeutic mechanism of AHT is based on the tonification of type I fibers. Therefore, AHT could be a method to train the transversus abdominis muscle and contribute to spinal stability.

In the study of Caufriez (6) with healthy subjects, the AHT had an influence on the static of dorso-lumbar spine. This fact was justified by the hypothesis that this technique produces a relaxation of the diaphragm, which activity depends of type I muscle fibers (43). Further studies ratified that AHT is based on tonification of these type I fibers (4,41). However, the action mechanism of AHT in the diaphragm is not clear yet. At the same time, the study shows that there is a normalization of paravertebral muscle tone and a better extensibility of

the posterior myofascial chain, but it is not caused by a structural flexibilization of the spinal column. Despite that, the sample of this study was not homogeneous and used a normalization technique in healthy subjects. More exhaustive studies should be done to confirm this hypothesis due to the low methodological quality of this report.

On the other hand, after doing this experimental clinical trial and based on his clinical practice, Caufriez hypothesized that most of spine deviations are consequence of a primary scoliotic dorsal curve due to a difference in the muscular tone of the diaphragmatic hemi-cupula (6). He stated that idiopathic scoliosis is part of the "postural deficiency syndrome" (44), and a high proportion of dorsal scoliosis are caused by an disequilibrium of the tonic postural activity between the diaphragmatic cupulas. Therefore, its reeducation might consist of the tonic harmonization of this muscle, an effect produced by the practice of AHT (6). With the aim to support this hypothesis, he reported a cases study (23) in which the practice of AHT in girls with mild or moderate idiopathic scoliosis could help to prevent the evolution of the curve. Still, these conclusions have to be carefully considered owing to the fact that it is a three-case study, which evidence level is significantly very low. At present, scientific evidence supports the conservative treatment of idiopathic scoliosis based on bracing and physiotherapy (45). Still, previous studies conclude that there is no robust evidence to recommend the use of one specific technique in the treatment of this condition (46).

Ramí-Colás *et al.* (24), based on the studies of Caufriez (23), studied the effect of AHT compared to Schroth method in idiopathic scoliosis in a non-randomized control trial. This study concludes that AHT has to be considered as a complementary therapy in the conservative treatment of idiopathic scoliosis since the Schroth method showed to be more effective. Nevertheless, AHT caused a greater correction in dorsal curves. These happenings suggest that AHT might be more effective in idiopathic scoliosis with dorsal curves. This could be justificated by Caufriez's theory, which states that disequilibrium in the diaphragm could be the cause of a dorsal in idiopathic scoliosis. Relaxing the diaphragm by performing AHT, the thoracic curve could be controlled. Due to the low methodological

quality of this study and its design, it is not possible to determine which method is more effective in the conservative treatment of idiopathic scoliosis and its conclusions have to be also carefully considered. More studies should be done to verify these theories.

Finally, the authors note that the implementation of new theories without previous validation is not recommended (47). As Herbert *et al.* (48) stated, clinical practice should not be changed due to theories or small experimental studies, but changes should be based on evidence from robust RCT with high methodological quality and sufficient effect size demonstrating that the intervention is worthwhile.

Limitations

The principal limitation of this review is related to the low methodological quality and level of evidence of selected studies. In addition, the different outcome variables used in the selected reports, studies could not be compared. The lack of consensus in the terminology has hindered the database searching. The fact that some articles were written in languages other than English, French, Spanish or Italian, as well as some articles weren't available with the full text has also limited the review.

The intern validity of the selected articles should be questioned: small samples, short follow-ups, AHT not as a unique intervention, lack of information about the exercises, non-randomized groups or lack of control group. These occurrences reduce the possibilities of obtaining reliable conclusions. Finally, the difficulty of drawing double blind studies in the field of physiotherapy is an important limitation to be taken in consideration.

Future research

RCT with a rigorous methodology are urgently needed: larger samples and follow-ups, homogenization of the intervention and its duration and adequate assessment test. The authors consider that these questions are necessary to be answered in a future research:

- Is AHT an adequate technique to treat pelvic floor or dysfunctions or spinal column dysfunctions?
- Does AHT decrease the tonic activity of the diaphragm, promoting its relaxation?
- Can AHT be considered as a PFMT technique?
- If the objective of AHT is to activate the co-synergy about transversus abdominis, diaphragm and pelvic floor muscles, how can it be evaluated?
- How can the correct execution of AHT be evaluated?

CONCLUSIONS

Although evidence does not support the use of AHT in pelvic floor and spinal disorders, there are some indications that AHT might be used as an adjunctive innovative treatment for pelvic floor dysfunctions. Finally, as much as this technique is gaining more popularity every day, authors encourage future researchers to investigate about this issue more rigorously with the aim to offer the patient an optimal intervention.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interests.

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Figure 1. Basic standing hypopressive abdominal position.

Figure 2. Identification and selection process of studies flow diagram.

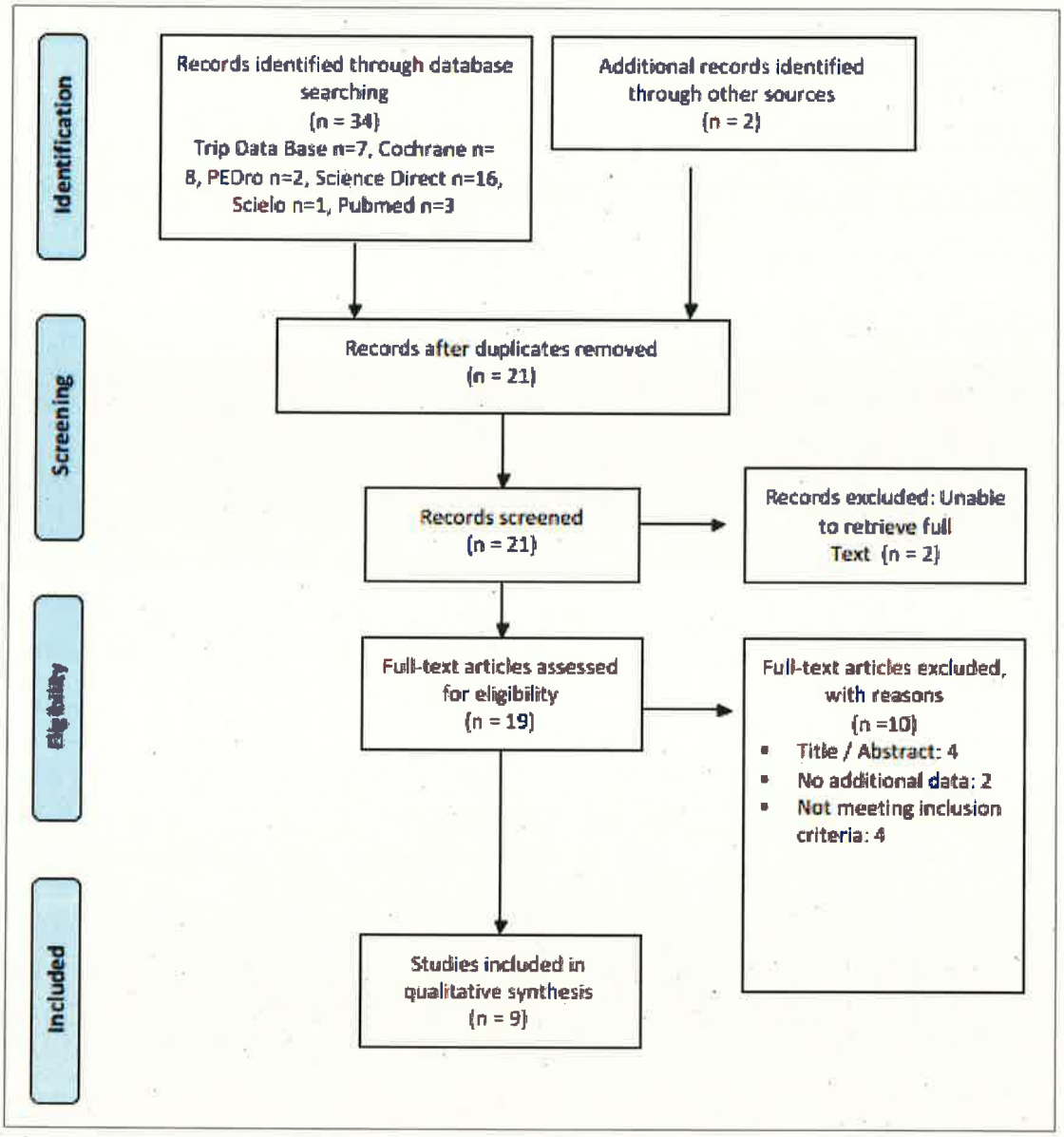

Table 1. Methodological quality assessment of all studies included.

STUDY (author, year)	JADAD	PEDRO	SIGN
Bernardes *et al.* 2012 (17)	3 / 5	5/10	1+
Castille *et al.* 2014 (20)	-	-	2-
Castille *et al.* 2015 (19)	-	-	2-
Caufriez *et al* . 2006 (6)	1 / 5	4/10	1-
Caufriez *et al.* 2011 (23)	-	-	3
Collado *et al.* 2013 (22)	2 / 5	3/10	1-
Rami-Colás *et al.* 2015 (24)	-	-	2+
Resende *et al.* 2012 (18)	3 / 5	5/10	1-
Serdà *et al.* 2010 (21)	-	-	2-

Table 2. The Jadad Scale.

	Bernardes *et al.* 2012 (17)	**Resende *et al.* 2012** (18)	**Collado *et al.* 2013** (22)	**Caufriez *et al.* 2006** (6)
1. Was the study described as randomized (this includes the use of words such as randomly, random, and randomization)?	YES = 1	YES = 1	YES = 1	YES = 1
2. Was the study described as double blind?	NO = 0	NO = 0	NO = 0	NO = 0
3. Was there a description of withdrawals and dropouts?	YES = 1	YES = 1	YES = 1	NO = 0
Give 1 additional point if: For question 1, the method to generate the sequence of randomization was described and it was appropriate (table of random numbers, computer generated, etc.) AND/OR If for question 2 the method of double blinding was described and it was appropriate (identical placebo, active placebo, dummy, etc.)	+1 = the groups allocation were undertaken using computer-generated random numbers to stratify the randomization	+1 = the groups allocation were undertaken using computer-generated random numbers to stratify the randomizatio n	0 = the method to generate the sequence of randomizati on was not described	0 = the method to generate the sequence of randomization was not described
Deduct 1 point if: For question 1, the method to generate the sequence of randomization was described and it was inappropriate (patients were allocated alternately, or according to date of birth, hospital number, etc.) AND/OR For question 2, the study was described as double blind but the method of blinding was inappropriate (e.g., comparison of tablet vs. injection with no double dummy)	0	0	0	0
SCORE	**3 / 5**	**3 / 5**	**2 / 5**	**1 / 5**

Table 3. The PEDro Scale

	Bernardes *et al.* 2012 (17)	**Resende *et al.* 2012** (18)	**Collado *et al.* 2013** (22)	**Caufriez *et al.* 2006** (6)
Eligibility criteria	YES (methods)	YES (methods)	YES (methods)	YES (methods)
Random allocation	YES (methods)	YES (methods)	NO	YES (methods)
Concealed allocation	NO	NO	NO	NO
Groups similar al basline	YES (methods)	YES (methods)	NO	NO
Participant blinding	NO	NO	NO	NO
Therapist blinding	NO	NO	NO	NO
Assessor blinding	YES (methods)	YES (methods)	NO	YES (methods)
Follow up > 85%	YES (results)	NO (results)	YES (results)	NO
Intention-to-treat analysis	NO	YES (results)	YES (results)	YES (methods)
Between-group difference reported	YES (methods)	YES (results)	YES (results)	YES (results)
Point estimate and variability reported	NO	NO	NO	NO
SCORE (/10)	5 / 10	5 / 10	3/ 10	4 / 10

Table 4. Risk of bias summary: author's judgement about each risk-of-bias item for the included studies.

	Random squence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other bias
Bernardes *et al.* 2012 (17)	+	?	?	?	+	?	-
Castille *et al.* 2014 (20)	-	?	?	-	-	-	-
Castille *et al.* 2015 (19)	NA	NA	NA	NA	-	-	-
Caufriez *et al.* 2006 (6)	?	?	?	?	-	-	-
Caufriez *et al.* 2011 (23)	NA	?	NA	NA	+	+	-
Collado *et al.* 2013 (22)	?	?	?	?	-	-	-
Rami-Colas *et al.* 2015 (24)	-	-	?	?	+	+	+
Resende *et al.* 2012 (18)	+	?	+	-	-	?	-
Serdà *et al.* 2010 (21)	NA	-	NA	NA	+	-	?

+: low risk
-: high risk
?: uncleared risk
NA: not applicable.

Study (author, year)	Design	Sample	Pathology	Mean age (years) Sex (%F, %M)	Intervention	Outcomes	Results
Bernardes *et al.* 2012 (17)	RCT	n=58 IG1: n=21 IG2: n=21 CG3: n=21	POP stage II	IG1: 51.9 IC2:56.7 CG3: 58.1 TOTAL: 55.8 100% F	DURATION: 1s/d at home, 12 wk. - IG1: PFMT (3 sets of 8-12 close to maximal c/d held for 6-8s in LD, SU and ST) + lifestyle advices. - IG2: AHT 10reps in LD and SP associated with PFMC for 3-8s + lifestyle advices. - CG3: had a single consultation with a physiotherapist and received information to do PFMC during increases AP + lifestyle advices.	- CSA of the levator ani muscle (cm^2)	G1 and G2 increased CSA of levator ani muscle compared to G3. There were non-significant differences between G1 and G2.
Castille *et at.* 2014 (20)	Cohort study	n=211 IG: 112 CG: 99	UI due to obstetric fistula	IG: 35.5 CG: 37 TOTAL: 36.25 100% F	DURATION: 1s/d at home, 48 wk. - IG: surgery + physiotherapy and health education program pre and post-surgery. Pre: 3 sessions (session1 received basic information, teach PFMC during 5s and basic AHT and preventive behaviors; session2 review, session3 optional review). Post: received further physiotherapy sessions and then return for a clinical examination. - CG: surgery. Received usual care and information.	- UI (g,ml) - QoL (Ditrovie scale)	In the IG the likelihood of recovery was 1,2 times higher than in CG. For women whose fistula was closed after surgery, the IG reduced the risk of stress UI in comparison to CG.
Castille *et al.* 2015 (19)	Cohort study	n=108 IG: 108 CG: not reported	UI due to obstetric fistula	Not reported 100% F	DURATION: 1s/d at home, 48 wk. - IG: surgery + physiotherapy and health education pre and post-surgery. Pre: 3 sessions (session1 received basic information, teach PFMC during 5s and basic AHT and preventive behaviors; session2 review, session3 optional review). Post: received further physiotherapy sessions and then return for a clinical examination.	- QoL (Ditrovie scale)	The QoL of IG women improved after 1-year post surgery. The number of women in IG with a closed fistula increased after 1-year post surgery. The number of women in IG with a failed repair or stress UI decreased after 1-year post surgery.

Collado *et al.* 2013 (22)	RCT	n=193 IG: 87 CG: 92	UI due to prostate cancer	Not reported 100% M	DURATION: Not reported. IG starts 3 wk before surgery and re-starts 3 months after surgery. - IG: surgery + assisted Biofeedback and AHT + PFMT and written instructions at home. CG: oral instructions on Kegel exercises.	- Individual continence improvement - Mean 24-Hour Pad Test & ICIQ-UI SF questionnaire	IG improves significantly individual continence compared to CG. There is non-significant improvement in the mean 24-hour Pad Test of IG compared to CG.
Resende *et al.* 2012 (18)	RCT	n=58 IG1: n=21 IG2: n=21 CG3:n=21	UI due to POP stage II	IG1: 51.9 IC2:56.7 CG3: 58.1 TOTAL: 55.8 100%F	DURATION: 1s/d at home, 12 wk. - IG1: PFMT (3 sets of 8-12 close to maximal c/d held for 6-8s in LD, SU and ST)+ lifestyle advices. - IG2: AHT 10reps in LD and SP associated with PFMC for 3-8s + lifestyle advices. - CG3: had a single consultation with a physiotherapist and received information to do PFMC during increases AP + lifestyle advices.	- MVC - Endurance (s) - Muscle activation (µV)	IG1 and IG2 showed a significant increased in all outcomes compared to CG3. No statistically differences were observed when comparing outcomes between G1 and G2.
Serdà *et al.* 2010 (21)	Cases report	n=33 IG: n=33 CG: not reported	UI due to prostate cancer	IG: 71.78 100%M	DURATION: 2s/wk, 16 wk supervisated and 8 wk at home. 2wk level1, 4wk level1+2 and 20wk level 1+2+3. - IG: progressive strength program (level1: overall posture re-education, level2: PFMT, level3: irradiated muscle strength resistance exercises: 2 series of 8 to 12 repetition of hypopressives.	- UI intensity, difficulty, frequency and limitation of activities - nocturia - QoL	There was a significant difference in the UI intensity, difficulty, frequency, nocturia, limitation of activities and QoL between before and after the prostatectomy.

POP=pelvic organ prolapse, RCT=randomized controlled trial, IG=intervention group, CG=control group, F=female, M=masculine, PFMT=pelvic floor muscle training, AHT= abdominal hypopressive technique, c/d=contractions per day, LD=lying down, SU=sitting up, ST= standing position, reps=repetitions, PFMC=pelvic floor muscle contraction, AP=abdominal pressure, WK:week, s/d:session per day, UI=urinary incontinence, s/wk=sessions per week.CSA=cross sectorial area, UI=urinary incontinence, SEMG=surface electromyography, MVC: maximal voluntary contraction, QoL=qualy of life, VAS-UI=visual-analogue scale of UI, FACT-P=functional assessment of cancer therapy scale-prostate.

Table 5. *AHT and pelvic floor dysfunctions*

Study (author, year)	Design	Sample	Pathology	Mean age (years) Sex (%F, %M)	Intervention	Outcomes	Results
Caufriez *et al.* 2006 (6)	RCT	n=29 IG: n= 15 CG: n=14	Normal subjects	Not reported Total:72.4%F, 27.6%M IG:66.6%F, 33.3%M CG:71.4%F, 28.6M%	DURATION: 1 group s/wk of 1h, 10 wks. - IG: AHT: 8 postures (st, st trunk inclination, semi-sitting, sitting, kneeling, quadruped, sp, mahoma) 3 times each, 15-30s, rest time 20s. - CG: postural training	- Spinal flexion (°) - OSL (cm) - Arrows: cervical, thoracic, lumbar - Isometric endurance trunk muscle ext.	There were statistically significant differences in IG compared to CG.
Caufriez *et al.* 2011 (23)	Cases report	n=3 IG: n=3 CG= not reported	Idiopathic scoliosis	12 years 66.6%F, 33.3%M	DURATION: 1 group session of 1h, 3s/wk, 12 wks + 1 individual s/d of 30min at home. - IG: AHT: 5 postures (st, st arms elevation, kneeling, quadruped, mahoma) 3 times each, 25s, rest time 20s.	- Cobb (°) - Spinal Rotation (Pedriolle) - Spinal Rotation (Nash/Moe scale) - Hunchback (°) - Spine Lateral deviation (cm)	Spine lateral deviation and hunchback improved in P1 and P3 and Cobb improved only in P1. No improvement was seen in other outcomes.
Rami-Colás *et al.* 2015 (24)	Non-RCT	n=29 IG1: n=19 IG2: n=10 CG: not reported	Idiopathic scoliosis	Total:12.41 IG1:11.79 IG2: 13.60 Total:55.2%F, 44.8%M G1:42.1%F, 57.9%M G2:80%F, 20%M	DURATION: IG1:17.37 months, IG2:12.60 months. - IG1: Schroth method. - IG2: AHT: 18 postures with 8 transitional postures, 3 times each, 25s.	- Cobb (°) - Spinal rotation (°)	No statistically significant difference was seen between groups.

IG=intervention group, CG=control group, RCT=randomized control trial, wk=week, sp=supine position, s/wk=sessions per week, h=hour, s/d=session per day, min=minutes, st=standing position, OSL=occipito sacral line, Ext=extensor, P=pacient.

Table 6. *AHT and spinal column dysfunctions.*

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