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Journal of Back and Musculoskeletal Rehabilitation 10 (1998) 23–29

Journal of
Back and
Musculoskeletal
Rehabilitation

The effects of the Aqua PT 3-in-1 at 90°F on lumbar flexion, heart rate and blood pressure

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Abstract

The purpose of this study was to examine the effects of dry hydrotherapy, dry heat therapy and massage therapy on heart rate, blood pressure and lumbar flexion range of motion using the Aqua PT 3-in-1 Therapy System. Thirty three healthy adult (24 female, nine male) subjects ranging from 20 to 60 years of age, with a mean age of 29 years, were tested. Subjects were placed in a prone position in the Aqua PT for 15 min, at 90°F, 7 lbs of pressure and 2 cycles per second with a dorsal massage from the gluteal fold to the inferior border of the scapulae. Pre- and post-treatment heart rate, blood pressure and lumbar flexion range of motion were recorded. The values were compared to a non-treatment control procedure which consisted of 15 min of lying prone at room temperature (72°F). A two-tailed *t*-test was performed for heart rate, blood pressure and lumbar flexion between the treatment measurements and the control measurements. Gross flexion (T12 measurement) and hip flexion (S2 measurement) showed a significant increase with the Aqua PT treatment, whereas there was no significant difference in the True Lumbar Flexion measurement (T12-S2). The heart rate and blood pressure measurements revealed no significant change between treatment and control. © 1998 Elsevier Science Ireland Ltd.

Keywords: Aqua PT; Dry hydrotherapy; Massage therapy; Lumbar flexion; ROM; True lumbar flexion

1. Introduction

A new modality in the physical therapy field is currently being used in a number of clinics across

the United States as well as parts of Europe and Asia. This machine is the Aqua PT 3-in-1 Therapy System (Aqua PT). The Aqua PT looks like a bed that is blanketed by a waterproof barrier and an acrylic top canopy that closes over the patient (Fig. 1A,B). The canopy contains 36 water jets capable of producing 2–11 lbs of force between 2 and 10 cycles per second (Fig. 2). The Aqua PT

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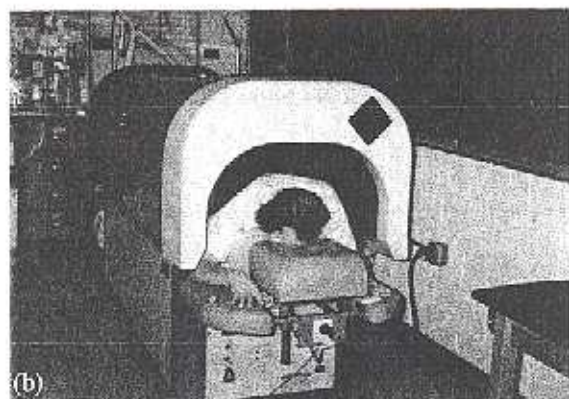


Fig. 1. The Aqua PT machine. (A) Demonstration by tester. (B) Test position.

incorporates three modalities: hydrotherapy, heat and massage. Hydrotherapy is the water jet streams pulsating on the patient (considered DRY hydrotherapy because the patient is protected by a waterproof membrane). The dry heat therapy is the temperature of air circulating throughout the Aqua PT chamber (the water temperature can be heated from 90 to 104°F). Massage therapy is the massage effect of the water jet streams as they pulsate over the body of the patient.

The dry heat and hydrotherapy modalities are two heating agents incorporated by the Aqua PT. The effects of heat as a modality results in vasodilation of the peripheral areas of the body and will lead to a decrease in preload to the heart. Decreased preload will lead to decreased stroke volume and will then lead to increased heart rate. Thus, no changes will be seen in blood pressure

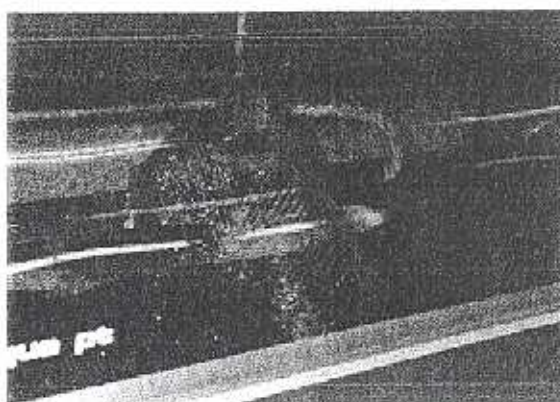


Fig. 2. Aqua PT water jets.

when exposed to increased temperature of the external environment [1–3].

Also, range of motion (ROM) is said to increase after exposure to superficial heating agents. Heat increases ROM by increasing the ease of elongating elastic structures and therefore, may decrease muscle spasms which will alleviate pain and allow for increases in ROM [2,4–8].

Massage therapy, another modality incorporated by the Aqua PT, has not been as intensely studied as to its effects on heart rate and blood pressure. The majority of the research on massage, heart rate and blood pressure combined has focused on massage of localized regions of the body. Massage has been found to increase blood flow to peripheral muscles and cause vasodilation of the vessels involved, thereby allowing one to believe that this would decrease blood pressure. The greatest effects of massage have been found on increasing ROM. Massage has been found to loosen and stretch out elastic tissue structures by altering the scar tissue matrix, breaking down intermolecular cross links and elongating collagen tissue [4,9,10].

As previously stated, heat and massage have contrasting effects on the body when used clinically. The only type of modality that resembles the Aqua PT by combining heat and massage is the whirlpool. However, the Aqua PT is dry heat, whereas the whirlpool is wet heat. Wet heating invariably elicits significantly higher cutaneous tissue and muscle temperature than dry heating

at the same level of intensity [5]. However, dry heating is much better tolerated, which permits its application at higher temperatures [5]. Thus, similar degrees of deep tissue heating can be obtained with the use of either of the two procedures. However, wet heating has been shown to produce discomfort and pain, which limits its application and detracts from its usefulness [11].

In treating hands, ankles, muscles and other conditions relatively near the skin, higher temperatures can be achieved using superficial heating modalities (hydrotherapy, paraffin, Fluidotherapy[®]). Superficial heating modalities treat a larger area of the body and the total amount of heat absorbed will be higher [5]. Surface heating modalities are much more effective in producing elevated temperatures than ultrasound or diathermy at depths of up to 1.2 cm. A dry whirlpool (i.e. Fluidotherapy[®]) delivers considerably more heat than paraffin or hydrotherapy because higher temperatures can be tolerated in a dry environment and are sustained over the course of the treatment [5]. For this reason it is believed that a person using the Aqua PT 3-in-1 Therapy System should be able to tolerate a higher sustained temperature for a longer time and therefore exhibit greater ROM without affecting heart rate and blood pressure when compared to physiological changes during a whirlpool treatment.

The purpose of this study was to examine the effects of dry hydrotherapy, dry heat therapy and massage therapy on heart rate, blood pressure and lumbar flexion range of motion using the Aqua PT 3-in-1 Therapy System.

2. Methodology

A sample of convenience comprised 33 healthy volunteers (24 female, nine male), ages 20–60 years old with a mean age of 29 years. After the subject had read and signed the informed consent that had been approved by the University of Massachusetts Lowell Institutional Review Board (IRB), the subjects were randomly assigned to a control treatment (non-Aqua PT) or an Aqua PT treatment. Pre- and post-treatment measurements were recorded for the following variables:

blood pressure (BP), heart rate (HR) and lumbar range of motion (LROM).

The subjects had their LROM measured using the Single Inclinator method. The single Inclinator method has been found to be a reliable and valid method of lumbar ROM by Newton and Waddell [12]. The Single Inclinator method has the benefit of being both quick and easy and provides researchers and therapists a unit of measure (degrees) that is understandable and comparable [13–16]. The Single Inclinator method is also the recommended method used for measuring lumbar ROM by the American Medical Association (AMA) [17].

The subject stood with heels 15 cm apart, arms at side. The examiner stood behind the subject and located the posterior superior iliac spine (PSIS) on the subject. A skin pencil was used to mark the horizontal midpoint between the spines, this marked the S2 spinous process. Another mark was made at the T12 spinous process. This was found by first palpating the inferior angles of the scapulae and finding the horizontal midpoint between the angles indicating the spinous process of T7. From the T7 spinous process, each spinous process below was caudally palpated one at a time until the T12 spinous process was found and marked. This was confirmed by counting the spinous processes cranially from S2 to T12.

To begin the measurement of the LROM, the inclinometer was placed on the S2 marking. With the subject standing in a comfortable position, the inclinometer was zeroed. Then the subject was instructed to 'Bend forward as far as you can while keeping your knees straight'. The inclinometer was held firmly on the S2 marking by the examiner as the subject moved into flexion (Fig. 3). The new measurement was recorded when the subject reached as far as they could flex. The subject was then instructed to 'Come back to a comfortable standing position'. The inclinometer was then held on the T12 marking and the flexion measurement was repeated. One S2 measurement and one T12 measurement were considered as one trial. A total of three trials were performed for each subject. To record the True Lumbar flexion, the S2 measurement was subtracted from the T12 measurement.



Fig. 3. Measurement position.

The Aqua PT treatment consisted of lying prone on the Aqua PT bed for 5 min to allow for physiological adjustments. After 5 min of acclimation, BP was measured using a sphygmomanometer and stethoscope and the HR was measured for 30 s using the radial pulse. The canopy was closed and the Aqua PT was activated for a 15-min treatment cycle. The Aqua PT settings of 90°F, 2 cycles per second and 7 lbs of pressure were used throughout the study for all subjects. The treatment area was limited to the subject's back from the gluteal fold to the inferior border of the scapulae. At the end of the treatment, the subject's HR and BP were immediately measured and recorded while he or she remained prone in

the bed. The subject then stood up and the LROM measurements were repeated. The subject was thanked for his or her cooperation and time contribution and was scheduled for the alternative treatment. The control procedure was identical except that the subject did not receive an Aqua PT treatment. A two-tailed *t*-test was used to analyze statistical data.

3. Results

Pre- and post-treatment measurements between the Aqua PT treatment and control subjects were compared using a paired two-tailed *t*-test (0.5 level of significance). The gross flexion (T12) and hip flexion (S2) showed significant increases with the Aqua PT treatments (Table 1).

The gross flexion measurement showed an increase in flexion with Aqua PT treatment by 1.9° compared to a decrease in flexion of 1.8° with no treatment. The net change of treatment compared to non-treatment was an increase of 3.7°. The measurements at S2, hip flexion, showed an increase in flexion with treatment of 2.7° as compared to no change with no treatment, resulting in a net increase of 2.7°.

True Lumbar measurements were calculated by subtracting the S2 measurement from the T12 measurement and by comparing the treatment

Table 1
Quantitative analysis of results

	Aqua PT Rx	Non Rx	Net change with Rx	Probability
ROM				
T12, Gross Flexion	1.9°	-1.8°	3.7°	0.0001*
S2, hip Flexion	2.7°	0.0°	2.7°	0.0296*
True lumbar	0.8°	1.8°	1.0°	0.5205
Heart rate	3.2 bpm	-3.3 bpm	-0.2 bpm	0.924
Blood pressure				
Systolic	4.1 mmHg	-2.1 mmHg	-2.0 mmHg	0.1018
Diastolic	0.2	3.6 mmHg	-0.4 mmHg	0.7156

* Significant at 0.05 degrees of freedom.

results to the control results. With the Aqua PT treatment there was a decrease of 0.8° and with the non-treatment there was a decrease of 1.8° (Table 1). The Aqua PT therefore indicated a net increase of 1° in True Lumbar Spine flexion when compared to non-treatment (Fig. 4).

The heart rate (HR) and blood pressure (BP) measurements both revealed no significant change between treatment and control (Table 1). Heart rate decreased by 3.5 b.p.m. with the Aqua PT treatment compared to a decrease of 3.3 b.p.m. with control subjects. The Systolic BP decreased by 4.1 mmHg with treatment compared to a decrease of 2.1 mmHg without treatment. The Diastolic BP increased by 0.2 mmHg with treatment and increased by 0.6 mmHg with non-treatment.

4. Discussion

This study was designed to show the effectiveness of an Aqua PT treatment at 90°F on lumbar muscle extensibility as well as determining the effects on heart rate and blood pressure. It was thought that the combined use of dry hydrotherapy, dry heat therapy and massage therapy of the Aqua PT would provide a relaxing environment for an individual. A clinical objective measure of 'relaxation' is to determine if the muscles of the patient have been relaxed. It was thought that

one way to measure relaxation would be to determine if the muscle length increased after treatment.

The goal of the study was to determine if the Aqua PT had any effect on the muscle length extensibility, not to determine the functional implications of gaining increased range of motion (ROM) within the lumbar spine. By using the Single Inclinometer method for measuring ROM, it was felt that the results would be measurable and comparable for statistical analysis and at the same time be a practical measure since it provides results that are meaningful to the physical therapist.

The changes in ROM at two locations (T12 and S2) as indicated by the Single Inclinometer protocol were used in measuring the flexion of the low back: the T12 measure is considered to be gross lumbar flexion; and the S2 measure is considered to be a measure of hip flexion. From these measures True Lumbar Spine flexion was calculated by subtracting the S2 measure from the T12 measure. The changes in both T12 and S2 proved significant with *p* values of 0.0001 and 0.0296, respectively. Functionally speaking, the net gains in True Lumbar ROM did not prove to be significant, however, in terms of muscle extensibility, the Aqua PT proved to be beneficial in relaxing and lengthening the erector spinae muscle group.

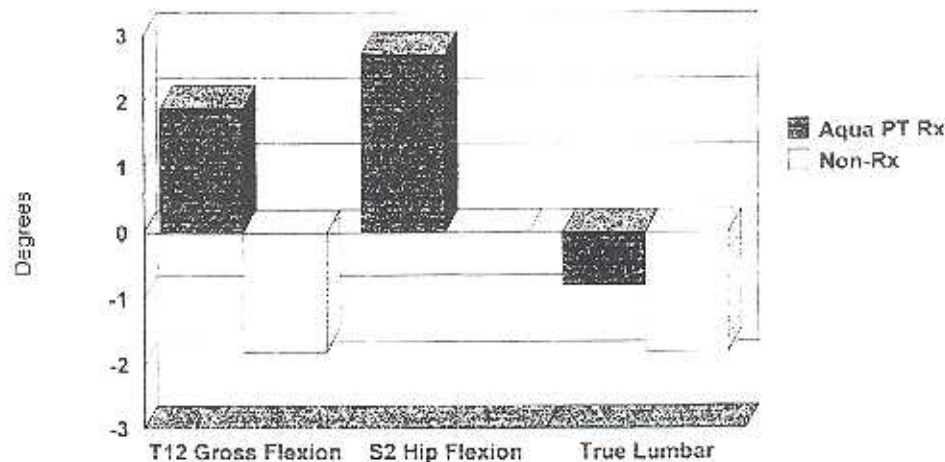


Fig. 4. Aqua PT Rx vs. non-treatment.

There arises a concern when measuring True Lumbar Spine flexion. When testing the subjects it was noticed that the subject could have gains in both the T12 and S2 measurements, but result in a decrease in True Lumbar flexion. This can occur if one has a greater increase in S2 than in T12. For example, if a subject's pre-treatment measurements were 100° for T12 and 50° for S2 and his or her post treatment measurements were 110° for T12 and 75° for S2 this would mean that this subject's pre-treatment True Lumbar flexion would be 50° and post-treatment would be 35°. This example illustrates that the subject had a decrease in True Lumbar flexion yet increased in ROM for both T12, gross flexion and S2, hip flexion. The authors feel that the separate T12 and S2 measurements give a better perspective on the extensibility of the muscles of the low back.

An explanation of a greater increase in T12 than S2 can be explained when one considers the musculature of the low back and takes into account where on the back the Aqua PT treatment was administered. The Aqua PT was set to treat the area of the back from the gluteal fold to the inferior angle of the scapulae. The T12 measure is a measure of the musculature of the back which includes areas above and below the T12 spinous process, which was treated by the Aqua PT. The S2 measure is a measure of the musculature around the sacrum and the pelvis which includes the gluteus muscles and the hamstrings. In this study, the Aqua PT treatment was administered, only to the gluteal fold and thus only treated the gluteal muscles and a small portion of the proximal hamstrings. Considering this, the entire length of the hamstrings were not given the full effects of the Aqua PT to increase their extensibility and allow for greater increases in the S2, hip flexion, ROM. Future research of the effects of the Aqua PT on lumbar ROM should apply treatment to the full length of the hamstrings and the erector spinae muscles.

The control subjects in our study, those without the Aqua PT treatment, showed a decrease in T12 flexion when lying prone for 15 min. Further research may be needed in which the subject is placed in the Aqua PT prone but in slight lumbar

flexion by placing several pillows or a wedge under the waist of the subject. In this study the Aqua PT has been shown to effect the extensibility of the muscle, however, it is not known if the benefits of this modality can also be matched or exceeded by applying a simple moist hot pack or other comparable modality. The Aqua PT does maintain constant environmental parameters compared with other modalities. Those parameters include temperature, pulse frequency, travel speed and pressure all of which may have an impact on the subject's flexibility.

As for the effects of the Aqua PT 3-in-1 system on HR and BP, it was observed that there were no significant changes in either the treatment or non-treatment groups. It is thought that the 15 min of lying prone was a causative factor for the slight decreases observed for HR and systolic BP. It was felt that the Aqua PT 3-in-1 did not cause enough generalized relaxation to have an effect on BP or HR. Therefore, one can conclude that the Aqua PT 3-in-1 is safe in terms of its effect on HR and BP in apparently healthy individuals.

This was a baseline study, performed at 90°F. The Aqua PT has a temperature range of 90–104°F. Future studies will repeat the project at higher temperatures. It is the opinion of the researchers that higher temperatures will show increases in ROM when compared to treatment at 90°F.

5. Conclusion

This study indicated that a 15-min treatment with the Aqua PT at 90°F significantly increased gross lumbar flexion (T12) range of motion and on hip flexion (S2) range of motion. Also, there was no significant change on True Lumbar flexion, heart rate or blood pressure.

The Aqua PT 3-in-1 system is a new modality. There is a relatively high cost to the Aqua PT, but it has minimum maintenance, saves personnel costs and improves staff productivity. Future research will study the effects of the Aqua PT at higher temperatures and various pressures on aspects of physiology.

Acknowledgements

The authors would like to thank David Cote of AMI, Inc., for his patience and confidence in bringing the Aqua PT bed to the University of Massachusetts Lowell.

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