The Effect of Bad Ragaz Lower Extremity and Trunk Patterns on Increasing Lumbar Spine Flexibility and Mobility in Normal Subjects

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Introduction and Historical Perspective

The Bad Ragaz Ring Method was originally developed in the 1930's in the town of Bad Ragaz, Switzerland. It implemented activities and exercises using the thermal springs as means of enhancing its effects. Later in the 1950's, a German physician structured this aquatic program and added elements of stabilization and floatation at the cervical region, pelvic region and ankles by way of place three floatation rings. He then called it the Bad Ragaz Ring Method. He also organized the aquatic exercises and activities into patterns and classified these patterns into three categories: trunk, lower extremity and upper extremity.

Furthermore, the new Bad Ragaz Ring Method integrated applied proprioceptive neuromuscular facilitation concepts and practices with the objective of facilitating or inhibiting motor activity. If facilitation is the goal, the objective will be to strengthen, promote coordination and promote kinesthesia and proprioception. If inhibition is the goal, then the pattern should focus of decreasing hypertonicity.

Based on the principle from which it was rooted in its structure, application of the bad ragaz patterns requires the use of a cervical floatation collar or vest, a floatation pelvic belt and ankle floats or rings. In order to effectively apply a bad ragaz pattern, the therapist needs to consider the water depth and water temperature. The temperature of the water must remain within the established thermo-therapeutic ranges (between 92˚F to 96˚F). The depth of the water should range between three and four feet depending on the height of the therapist allowing the therapist to retain control of the patient at all times and maintain his center of gravity and the metacenter aligned.

Clinical Objectives

From a biomechanical viewpoint, some bad ragaz patterns will stimulate joint receptors in an effort to promote proprioception and joint stabilization. These patterns emphasize joint surface approximation. Other patterns focus on increasing range of motion and decreasing pain integrating distraction techniques to achieve the means. When strengthening is the aim, manual resistance can be integrated into the specific pattern. Hand placement of the therapist and the position of the patient are quintessential factors for effectiveness in the application of the patterns and their effectiveness in goal attainment.

Likewise, some patterns are active while others are passive. Active bad ragaz pattern can also be called "command patterns" because they involve a command or instructions on specific movements. In order to effectively perform these, a certain level of understanding and receptiveness on the part of the patient is expected in order to follow instructions from the therapist.

From a clinical perspective, the Bad Ragaz patterns have been useful in:

- Decreasing pain
- Increasing range of motion
- Increasing muscle strength
- Increasing coordination
- Improving proprioception and kinesthesia
- Decreasing spasticity

Originally, the application of Bad Ragaz patterns was contraindicated in patients with upper motor neuron lesions. However, if the objective is to facilitate motor activity, new developments have demonstrated that the Bad Ragaz Ring Method has proven effective as a neuromuscular re-education approach to rehabilitation of these patients. Currently, it is a valuable aquatic intervention in the rehabilitation of patients with musculoskeletal, neurological and cardiopulmonary conditions.

Low Back Pain

Although low back pain is recognized as a symptom, it is associated with a myriad of clinical problems some of which might have musculoskeletal etiology and others rooted on neurological origins. Perhaps the complexity of its etiology and clinical manifestations has prompted rehabilitation clinicians to refer to it as a condition rather than a symptom. For instance, it may result from spinal nerve root compression secondary to an intervertebral disc herniation. It could also be caused by widespread spasmodic activity in the paraspinal and lumbar musculature.

According to Porterfield and DeRosa (1998), 80% of adults experience this symptom during some period in their lives. The descriptor that the patient uses to report this symptom to the clinician depends on the type of clinical problem causing the symptom. If the problem has neurological roots, the patient will describe as radiated pain even though it may also be localized to the area where the problem originates. This might be the case when there is compression of one of the spinal nerve roots giving origin to the sciatic nerve. The pain will follow the distribution of this nerve along the lower extremity. If the soft tissues are involved, then the patient will describe it as localized. Palpation of the soft tissue during the examination of the patient will lead to identification of trigger points

and spasms in the low back muscles in the latter. Upon examination, muscle spasms are commonly identified in the three components of the erector spinae (iliocostalis, longissimus and spinalis) and in the deep transversospinal muscles (multifidi, rotatores, intertransversarii, interspinalis and semispinalis). In either scenario the patient tends to reflex guard against the pain, thus assuming a posture that might aggravate the onset of spasmodic activity to other soft tissues such as the quadratus lumborum and external rotator muscles. Regardless of the cause of the low back pain, postural deviations due to primary reflex guarding against the pain and secondary spasmodic activity and mal-alignment of the lumbopelvic complex leads to limitations in lumbar spine and sacroiliac flexibility and mobility secondary to decreased resilience of the connective tissue structures supporting this area in addition to the spasms of the extensor muscles.

The traditional physiotherapeutic management of patients with low back pain associated with radiculopathy emphasizes lumbosacral decompression to free the spinal nerve roots, thereby, decreasing the pain. Some activities and exercises integrating posterior iliac rotation or posterior pelvic tilt are believed to facilitate decompression in this area. Other strategies in the physical therapy management of these patients include active open chain movements of the lower extremity facilitating lumbopelvic rhythm.

Bad Ragaz Applications to Low Back Pain

There are a number of specific Bad Ragaz lower extremity and trunk patterns, which biomechanically apply these same principles some of which are identical to the described activity on land. Trunk patterns that are said to promote lumbar decompression include: passive relaxation and passive pelvic tilt. Lower extremity patterns that promote lumbopelvic rhythm emulate the knee-to-chest exercises practiced commonly on land. The bilateral symmetrical lower extremity #1 pattern is a perfect example of this biomechanical application.

The Passive Trunk Elongation with Pelvic Hold pattern focuses on alternately releasing tight connective and soft tissue structures including the myofascia bilaterally. Likewise, the Isotonic #1 and 2 patterns recruit the deep transversospinal rotators as well as the lateral flexors unilaterally. The Isotonic #1 pattern promotes rotation of the lumbar spine and pelvis. The Isotonic #2[1] is a "command" pattern, which requires lateral flexion of the lumbar spine. If these patterns are applied, the therapist must exercise caution because the unilateral approximation movement characteristic of the Passive Trunk Elongation with Pelvic Hold pattern should be avoided on the side of the radiculopathy as it could

[1] This pattern was initially known as the Isokinetic Pattern. In their analysis of this intervention, Dr. Vargas and Professor Bayron concluded that the description of the pattern was an antithesis to the meaning of an isokinetic activity. Henceforth, they named it **"Isotonic #2"** pattern.

further aggravate the pain. This pattern combines assisted buoyancy movements of the trunk with a gentle unilateral stretch to the tight structures. Cailliet (1996) refers to such a stretch as mobilization of the soft and connective tissues. Excessive spinal rotation on the side of the radiculopathy can once again aggravate the problem. However, on a positive note, these patterns might have an effect on the elastic and plastic properties of the ligaments in this region of the spine as well as in releasing tight soft tissue.

The purpose of this study was to determine whether or not an increase in lumbar flexion is observed following the application of selected Bad Ragaz lower extremity and trunk patterns.

Method

The study was conducted at the therapeutic pool of the Physical Medicine and Rehabilitation Department in a teaching medical center located in San Juan, Puerto Rico. The authors hypothesized that there would be an increase in lumbar spine flexibility and mobility after the application of the selected Bad Ragaz Trunk and Lower Extremity patterns. The null hypothesis would, therefore, state that no significance difference would be detected between the pre- and post-measurements.

Subjects

Twenty-eight subjects volunteered for this study, nine males and nineteen females (Table 1). Although the differences between genders were established, this was not considered a limitation in the study because it was not the central focus of the study.

No.	Gender	Pre-BR	Post-BR	DiffBR
1	Female	36	41	5.00
2	Female	37	44	7.00
3	Female	60	48	-12.00
4	Female	37	38	1.00
5	Female	28	41	13.00
6	Male	39	50	11.00
7	Male	36	53	17.00
8	Male	42	60	18.00
9	Male	48	51	3.00
10	Male	50	50	.00
11	Female	62	67	5.00
12	Male	58	63	5.00
13	Female	46	46	.00
14	Female	38	42	4.00

15	Female	41	42	1.00
16	Female	35	33	-2.00
17	Female	27	39	12.00
18	Female	31	26	-5.00
19	Female	41	42	1.00
20	Male	47	49	2.00
21	Female	53	59	6.00
22	Female	37	43	6.00
23	Female	47	53	6.00
24	Female	31	31	.00
25	Female	40	44	4.00
26	Female	28	36	8.00
27	Male	34	45	11.00
28	Male	32	45	13.00

Table 1

All subjects were thoroughly oriented to the study with full understanding of the procedure and objectives. The participating subjects were required to sign an informed consent form (Appendix A), which specified all conditions of the study including risks and possible hazards, temperature of the water, permission to photograph for publication purposes, and, most importantly, the rights and privileges as volunteers in the study.

Instrumentation

This study utilized a non-invasive approach to the collection of data. Data was collected through measurement of lumbar spine flexion using the Acumar Dual Digital Inclinometer (Figure 1).

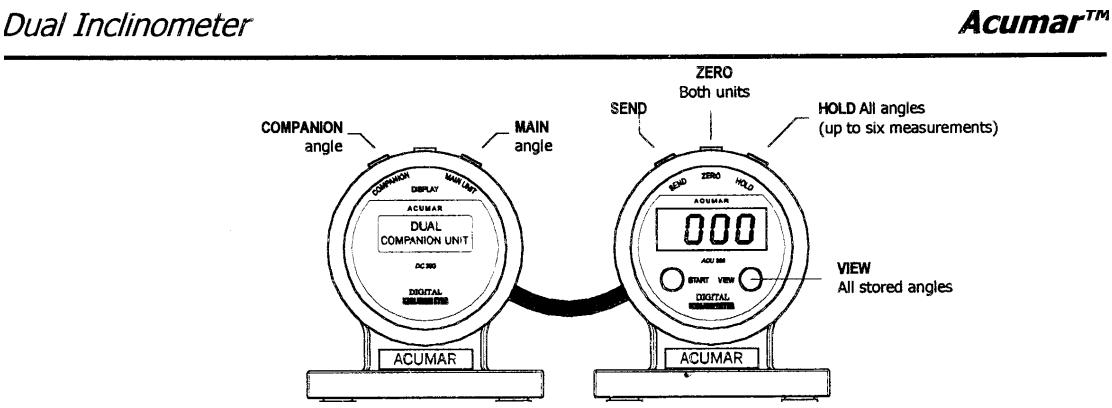


Figure 1

The rationale for the use of inclinometry for purposes of data collection was the fact that it has been considered "a feasible and potentially accurate" method to measure spinal range of motion. The Acumar Dual Digital Inclinometer uses a gravity sensor that determines the angle of movement. This instrument consists

of a main and companion units. When connected together, it reads both units, automatically computes the data and displays the sum of the angles (A+B). The main unit controls both units simultaneously.

This research study followed a method established by the American Medical Association, Guides to the Evaluation of Permanent Impairment (4th and 5th Editions). The inclinometer is held firmly against the subcutaneous skeletal landmark while the spine is moving through the range.

Procedure

All subjects were paired as practitioner and receiver. Once the participants signed the consent form, a pre-Bad Ragaz measurement of lumbar flexion was recorded. Once the digital inclinometer was placed at the correct landmarks in the upright position, the subjects were asked to bend down and attempt to touch their feet. A digitalized reading was the recorded. Bad Ragaz floatation equipment consisting of the cervical floatation sprint bodyfit collar, the floatation pelvic belt and ankle floats was needed for the application of the selected trunk and lower extremity patterns. Ankle floats were not used with the exception of the Passive Pelvic Tilts because in all other selected patterns the position of the therapist was either at the patient's feet or between the patient's legs requiring for the lower extremities to be free to move in the water. Only patterns promoting lumbosacral decompression, lumbopelvic rhythm or soft and connective tissue release in the lumbosacral region were selected for the study. These included:

- Passive Pelvic Tilts (photo 1A)
- Passive Trunk Elongation with Pelvic Hold (photo 2A)
- Passive Trunk Elongation with Knee Hold (photo 3A)
- The Bilateral Symmetrical Lower Extremity #1 Pattern (photo 4A)
- Isotonic #1 (photo 5A)
- Isotonic #2 (photo 6A)

All subjects received instructions on the upright position to assume and the movement required for measurement. The subject's trunk was aligned in neutral position with a moderate base of support. A pre-session measurement of lumbar flexion was recorded. The point of firm contact with the companion unit was the spinous process of T12, while the main unit was placed against the sacrum. The instrument recorded three measurements of lumbar spine flexion and calculated the average of the three. Afterwards, the subject donned the floatation gear and the therapist was positioned correctly for application of the selected patterns. All selected patterns were explained to the subjects prior to the execution of the movement or technique. All selected patterns were performed in sequence for an average of five repetitions (Photo 6A).

Following the Bad Ragaz session, a post-session measurement of lumbar flexion was collected and recorded. The data recorder remained in the pool deck and was charged with calling the patterns to be applied by the therapists. The paired subjects then switched roles and the procedure was repeated (photo 7A). The pre- and post-measurements of lumbar flexion as recorded for all twenty-eight subjects are illustrated in Table 1.

Data Analysis and Results

The "paired t test" computes the mean and standard error in pre- and post-measurement differences and examines the significance between these differences. Therefore, this was the chosen statistical instrument used for data analysis in the study. In order to test the hypothesis, collected data was analyzed with a $\propto$ = .05 level of significance. The Statistical Package for the Social Sciences (SPSS) computerized program was utilized to conduct the data analysis.

Table 2 shown below emphasizes "t test" statistical calculations based on the results obtained in the pre- and post-Bad Ragaz measurements collected.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PREBR	40.75	28	9.571	1.809
	POSTBR	45.75	28	9.399	1.776

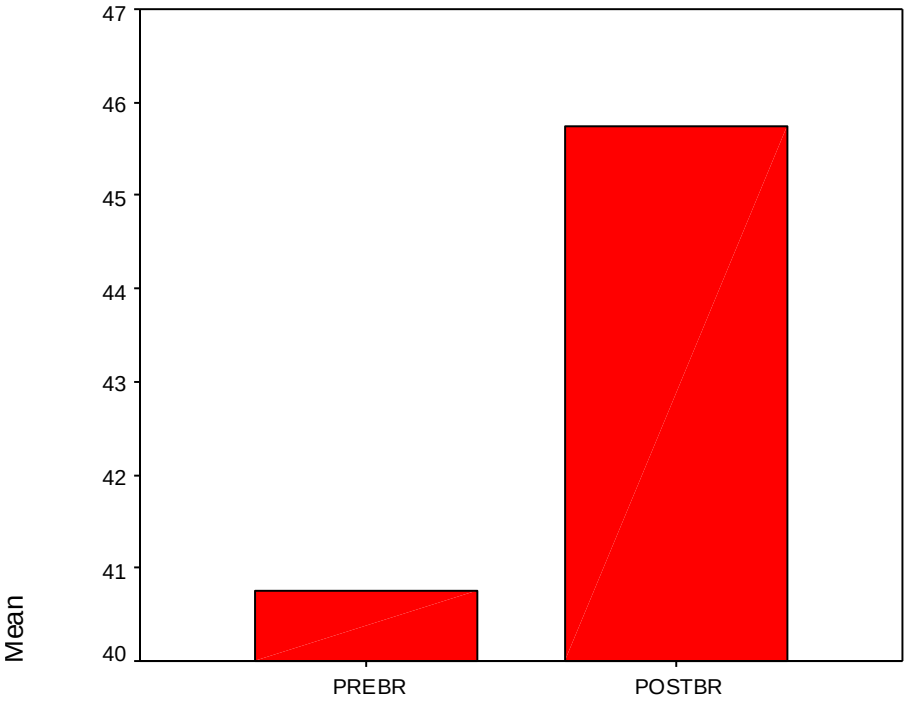
Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PREBR & POSTBR	28	.763	.000

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1 PREBR - POSTBR	-5.00	6.538	1.235	-7.54	-2.46	-4.047	27	.000

Table 3



Graph 1

In order to determine whether or not there is a significant difference, the "t" value must fall within the interval of the difference noted in the upper and lower range columns. The results of the "t test" seem to indicate that there is a significant difference between the pre- measurements of lumbar flexion taken prior to the application of the selected Bad Ragaz Patterns and the post-measurements recorded after the session (Graph 1). Therefore, based on these results, the authors in this study failed to reject the hypothesis, thereby, maintaining that there is, indeed, a potential for these trunk and lower extremity Bad Ragaz patterns to increase lumbar spine flexibility and mobility. The null hypothesis was rejected.

Discussion

This is considered a pilot study setting the stage for a replication study to follow that would address potential threats to the internal validity of this research. The replication study would research subjects with a specific diagnosis, increase the sample, and randomize the subjects. As a recommendation, the replication study should be a true experimental design, which might provide evidence that the increase in lumbar flexion could be attributed to the effects of these patterns on plastic and elastic properties of connective and soft tissue, which at this point is a limitation to this study.

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About the authors

Dr. Luis G. Vargas has distinguished himself as an academic educator and administrator, a physical therapist and renowned national and international expert in aquatic rehabilitation. He has occupied multiples administrative academic and clinical positions at all levels throughout his career. Dr. Vargas holds a Bachelor of Science in Physical Therapy from the University of Puerto Rico, a Master of Education in Educational Administration from Cambridge College in Cambridge, Massachusetts and a Doctor of Philosophy Degree in Higher Education Administration from The Union Institute, Graduate College in Cincinnati, Ohio. He has made numerous contributions to the aquatic rehabilitation industry over the years beginning with the development of his Diagnostic Aquatics Systems Integration Theory. He is the creator of several aquatic therapy interventions such as Cardiaquatics Protocol, the Clinical Wassertanzen Protocol, the Adapted Pediatric Wassertanzen Protocol, the Aquatic Spasticity Inhibition Protocol (ASIP), and coauthored with Professor Flavia Bayron the design and development of the Sacroiliac Dysfunction (SID) Protocol. Dr. Vargas is the recipient of the 2000 Dolphin Award from the Aquatic Therapy and Rehabilitation Institute at that year's symposium. He has authored a book titled "Aquatic Therapy: Interventions and Applications", which will be published in the fall of 2003. He has become an international celebrity in the aquatic rehabilitation industry presenting at international symposia, conferences,

and congresses and conducting workshops and seminars throughout the world in countries such as Puerto Rico, Brazil, Argentina and Costa Rica.

Professor Flavia E. Bayron has distinguished herself as a physical therapy icon in the area of musculoskeletal rehabilitation in Puerto Rico, Central America and South America. The areas of orthopedics and sports medicine highlight her expertise as a clinician and academician. She holds a Bachelor of Science Degree in Physical Therapy and a Master of Public Administration from the University of Puerto Rico. Professor Bayron's contributions to the physical therapy and academic community have extended over her enriched career. She has served as physical therapist on Olympic committees and international athletic competitions. She is also a renowned expert and consultant in the area of ergonomics for industries and the corporate world. In the academic year 2002-2003, Professor Bayron served as Interim Director of the Program in Physical Therapy at the University of Puerto Rico, Medical Sciences Campus, College of Health Related Professions where she has been a member of the physical therapy faculty for over fifteen years. She has been involved as collaborator in multiple research projects and collaborated with Dr. Vargas in the design and development of the Aquatic Sacroiliac Dysfunction Protocol. She was presenter at the 14th Congress of the World Confederation of Physical Therapy to be held in Barcelona, Spain in June 2003.

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