

Comparative Sports physiotherapeutic efficacy of Bowen Technique and Muscle Energy Technique on Elite athletes Hamstring Tightness

¹T.Karthikeyan, ²Jyoti Bagri, ³Jayant, ⁴Mohit Yadav, ⁵Sonu Sharma, ⁶Bijender, ⁷Nikita

¹Associate Professor & Head, Department of Physiotherapy, Gurugram University, Gurugram

²Assistant Professor, Department of Physiotherapy, Gurugram University, Gurugram

³Physiotherapist, Department of Physiotherapy, Gurugram University, Gurugram

⁴Physiotherapist, Department of Physiotherapy, Gurugram University, Gurugram

⁵Physiotherapist, Department of Physiotherapy, Gurugram University, Gurugram

⁶Assistant Professor, Department of Physiotherapy, Gurugram University, Gurugram

⁷Physiotherapist, Sprouts Child Development Center, Gurugram

DOI: <https://doi.org/10.5281/zenodo.11653237>

Published Date: 14-June-2024

Abstract: The movement of the human body is caused by the muscular system. There are about 700 muscles attached to the bones of the skeletal system that help to make up half of the person's body weight roughly. Skeletal muscles are made up of contractile and non-contractile connective tissues. The characteristics of contractility and irritability are given by the contractile elements of the muscle.

Aim: The Aim of this study is to compare “effect of bower technique versus muscle energy technique on asymptomatic subjects with hamstring tightness” **Materials and Methods:** A Quasi Experimental study design consisting of reviews of charts of hamstring tightness patients. Thirty patients were included, (50%) were males, (50%) were females; the average age was 18-24 years. All the patients are presented with hamstring tightness underwent goniometer and sit and reach test. Pre- and post-Treatment of Group A patients received (Bowen technique) and Group B patients received (Muscle energy technique) scores on the improve range of motion strength of muscle and physical functional of the goniometer and sit and reach test were analyzed.

Results: The pre and post test values were assessed by Bowen Technique and Muscle Energy Technique in Group A and Group B. The calculated t values by unpaired t test were in group A is 5.72 and Group B is 3.52. The calculated t values were more than the table value 2.05 for 5% level of significance at 28 degrees of freedom.

Conclusion: In the present sample, Bowen technique had a positive and significant effect on the improve range of motion strength of muscle and physical functional of the goniometer and sit and reach test before and after therapy.

Keywords: Bowen technique, Muscle energy technique, Goniometer, Sit and reach test.

1. INTRODUCTION

The movement of the human body is caused by the muscular system. There are about 700 muscles attached to the bones of the skeletal system that help to make up half of the person's body weight roughly. Skeletal muscles are made up of contractile and non-contractile connective tissues¹. The characteristics of contractility and irritability are given by the contractile elements of the muscle².

The greatest measurable force that can be exerted by a muscle or muscle group to overcome resistance during single maximum effort is the muscle strength. The ability of a muscle to contract repeatedly against a load (resistance), produce and sustain tension, and resist fatigue over an extended period of time is the muscle endurance³.

Hamstring muscle is located at the back of the thigh. This muscle starts in the gluteal region and courses through the back of the thigh and ends in the popliteal fossa⁴. Three muscles together form the hamstring muscle. Biceps femoris, semitendinosus muscle and semi membranous muscle⁵. These muscles are responsible for the flexion of the knee joint as well as help in extension of the thigh.

The major aetiological factors in musculoskeletal injuries are considered to be due to muscle stiffness of the lower extremity and the consequential decrease in joint flexibility⁶. The ability of the muscle to lengthen allowing one joint (or more than one joint) to move through the range of motion is due to the flexibility of the muscle. If a muscle has good flexibility it will allow muscle tissue to accommodate to imposed stress more easily and allows efficient and effective movement⁷. If there is enhanced muscle flexibility it will assist in preventing or minimizing injuries and enhance performance of the muscle. The muscle which is found to be most prevalent for the tightness in the body is the hamstrings⁸. Worrel, et al. stated that a "lack of hamstring flexibility was the single most important characteristics of hamstring injuries in athletes". Tight hamstrings have been involved in lumbar spine dysfunction and shows strong positive correlation between low back pain and reduced hamstring flexibility⁹. Tightness of the muscle is a limiting factor for ideal physical performance as well as daily activities and an important intrinsic factor for sports injuries¹⁰.

Muscle tightness –Muscles contract by neural stimulation to the motor units that are scattered among the muscles like little electric wires. Muscle fibers contract by sliding across each other to pull the joints closer together. Actin and Myosin, two of the muscle-contracting proteins, make these fibers stick together. However, prolonged neural stimulation of the muscle causes them to stay contracted, keeping the joint and surrounding tissues short and tight.

Muscle stiffness is when muscles feel tight and more difficult to move than usual. Most relevant cause of muscle stiffness is due to unused due to muscle pain and cramping¹¹.

Range of motion is very important in the case of muscle flexibility. Following factors affect flexibility of the joint. They are Joint structure- there are several different types of joints in the human body. Some have a greater range of motion than others. Age and Gender-range of motion and flexibility naturally decreases as you get older¹².

Connective tissue- Deep connective tissue such as fascia and tendons can limit range of motion. These tissues differ in their ability to return to their original resting length (elasticity) and their tendency to keep a new and greater length after stretched (plasticity). Ligaments are not elastic, but can respond to stretching. Over time connective tissues lose water content and the collagen in ligaments and tendons can become thicker and less flexible.

Muscle bulk- Big muscles adversely affect range of motion. It may be difficult for very bulky athletes to complete certain stretches because their muscle mass gets in a way.

Proprioceptors - these are tiny sensors located inside muscle fibers that provide information about joint angle, muscle length and muscle tension. Careful, purposeful, slow stretching can ensure that these sensors don't trigger spasms or reflex actions that don't help build flexibility.

Bowen Technique - The Bowen technique or Bowen therapy is an alternative type of physical manipulation named after Australian Thomas Bowen. This technique works on the soft connective tissue (fascia) of the body. It can be used to treat musculoskeletal or related neurological problems including acute sports injuries and chronic or organic conditions. It is gentle and relaxing and does not use forceful manipulation. Bowen therapy is performed on the superficial and deep fascia. The fascia, or soft tissue, is the part of the connective tissue that envelops, separates and influences every organ and tissue in the body.

Muscle Energy Technique - Muscle energy techniques describes a broad class of manual therapy techniques directed at improving musculoskeletal function or joint function, and improving pain. Historically, the concept emerged as a form of osteopathic manipulative diagnosis and treatment in which the patient muscles are actively used on request, from a precisely controlled position, in a specific direction, and against a distinctly executed counterforce. It targets the soft tissue primarily and can be called as active muscular relaxation technique.

Need for the study

1. The purpose of this study was to investigate the effect of Bowen Technique versus Muscle Energy Technique on asymptomatic subjects with hamstring tightness.
2. To understand about both Bowen and Muscle Energy Techniques.
3. To find out the most effective technique for improving hamstring muscle tightness.
4. Hence I concluded to do my research on “Effect of Bowen Technique versus Muscle Energy Technique on asymptomatic subjects with hamstring tightness”.

Aim of the study

To find out the effectiveness of Bowen Technique versus Muscle Energy Technique on asymptomatic subjects with hamstring tightness.

Objectives of the study

1. To have in depth knowledge about the muscle hamstring.
2. To improve the hamstring flexibility in healthy individuals.
3. To know about both Bowen and Muscle Energy Techniques.

To find out the effectiveness of Bowen Technique versus Muscle Energy Technique on asymptomatic subjects with hamstring tightness.

Variables of the study

(a)Independent variables

Bowen Technique.

Muscle Energy Technique.

(b)Dependent Variables

Goniometer(ROM)

Sit and reach test

2. METHODOLOGY

MATERIALS

1. Treatment couch.
2. Pillows.
3. Blankets.
4. Goniometer.
5. Inch tape.

METHODOLOGY

1. Goniometer is used to measure popliteal angle.
2. Inch tape is used to measure sit and reach test value.

POPULATIONS

Patients with age group of 18-24 years healthy individual of same sex.

STUDY DESIGN

Quasi Experimental Design.

Pre and post experimental study design.

STUDY SETTING

Department of physiotherapy Gurugram University Gurugram.

STUDY DURATION

Study was conducted for a period of 1-5days.

TREATMENT DURATION

Study was carried out for 1-5 days for each patient.

Group A patients received Bowen Technique was performed for in 3 alternate sessions.

Group B patients received Muscle Energy Technique was performed for in 3 alternate sessions.

STUDY SAMPLING

Convenient Sampling Method.

SAMPLE SIZE

Sample size is 30 subjects.

Group-A (Bowen technique) 15 patients.

Group-B (Muscle Energy Technique) 15 patients.

3. CRITERIA FOR SELECTION

INCLUSION CRITERIA.

1. Elite athletes with hamstring tightness.
2. Elite athletes Only males.
3. Elite athletes Age group between 18 to 24 years.
4. Elite athletes 20°-50° degree active knee extension loss with hip in 90° of flexion.
5. Elite athletes Full passive range of motion of knee extension.
6. Elite athletes willing to participate in the study.

EXCLUSION CRITERIA

1. Elite athletes having low back pain and neurological pain.
2. Elite athletes if they have any history of lower extremity injury in past 3 months.
3. Elite athletes Any fracture or surgery done for back, pelvis, hip or knee.
4. Elite athletes Spinal deformity.
5. Elite athletes Any recent abdominal surgery.
6. Elite athletes Any congenital deformities in lower limb.

PARAMETER GONIOMETER

Goniometer an instrument used to measure the ROM. Goniometer is derived from two Greek words, gonio means angle and meter means measure. The amount of motion that is available at a joint called range of motion. Therefore, goniometry refers to the measurement of angles in particular the measurement of angles created at human joint by the bones of the body.

TYPES

1. Universal Goniometer.
2. Gravity Depending Goniometer.

3. Electro Goniometer.

PROCEDURE

TREATMENTPROCEDURE

Subjects were selected by convenient sampling method.

30 subjects who fulfilled inclusion and exclusion criteria were selected by random sampling method, out of them 15 were allotted in Group A and 15 in Group B.

Subjects were clearly explained about the study and written informed consent was obtained from the subjects who fulfilled the criteria.

After completing the informed content and they were explained about the scale and the scale was administered.

Proper instructions such as purpose, safety measures, comfort, precautions and psychological support were given to the subjects.

All vital signs were checked.

While doing the assessment, the subject's willingness to continue the procedure with or without rest was given preference.

Both Group A and Group B subjects were involved for pre test assessment.

Group A underwent Bowen Technique and Group B underwent Muscle Energy Technique.

SIT AND REACH TEST

This test involves sitting on the floor with legs stretched out straight ahead.

Shoes should be removed and the soles of the feet are placed against the wall.

Both knees should be locked and pressed flat to the floor.

With the palm facing downward, the subject reaches forward along the measuring line as far as possible. Ensure that the hands remain at the same level.

After some practice, the subject reaches out and holds that position for at least one-two seconds while the distance is recorded.



Fig 3.1 Sit and Reach Test.

POPLITEAL ANGLE MEASUREMENT [ACTIVEKNEE EXTENSION]:

Subject will be in supine position on the plinth.

Subject then flexes hip to 90°.

Subject then actively extends each knee in turn.

Fulcrum of the Goniometer will be placed over the lateral condyle of the knee joint and popliteal angle is measured.



Fig 3.2. Popliteal Angle Measurement.

Bowen technique

Patient Position: Subject is lying prone on the plinth.

The thumb is placed on top of the designated muscle.

Quietly hook the thumb into the lateral edge of the muscle to form a challenge or pressure against the muscle.

As we begin to flatten the thumb in a medial direction, the muscle will pluck or plop or respond in some manner.

Carry the skin and challenge the muscle.

First with the thumbs (left side of the body) followed by the fingers (right side of body). Often the hands are placed on the back with an inch of space between the thumbs and fingers so that the hands can play the muscles simultaneously.

Alternate day intervention will be given for 1 week.

The treatment time for each session will be 20 minutes.



Fig 3.3 Bowen Technique.

Muscle Energy Technique:

Patient Position: Subject is lying supine on the plinth.

In this technique, first the subject's knee was extended till the subject feel hamstring tightness.

Moderate isometric contraction of the hamstring muscle was given for a period of five seconds.

A three second relaxation period was given.

This technique will be repeated for three times (for a total of four contractions).

Alternate day intervention will be given for 1 week.

The treatment time for each session 20 minutes.



Fig 3.4 Muscle Energy Technique.

4. DATA PRESENTATION

TABLE-4.1 (a): MEAN DIFFERENCE BETWEEN GROUPA AND GROUPB OF RIGHT AND LEFT IN POPLITEAL ANGLE

GROUPS	MEAN DIFFERENCE	
	RIGHT	LEFT
GROUP-A (BOWEN TECHNIQUE)	7.73	5.4
GROUP-B (MET)	3.4	3

FIG.4.1(a): MEAN DIFFERENCE BETWEEN GROUPA AND GROUPB OF RIGHT AND LEFT IN POPLITEAL ANGLE

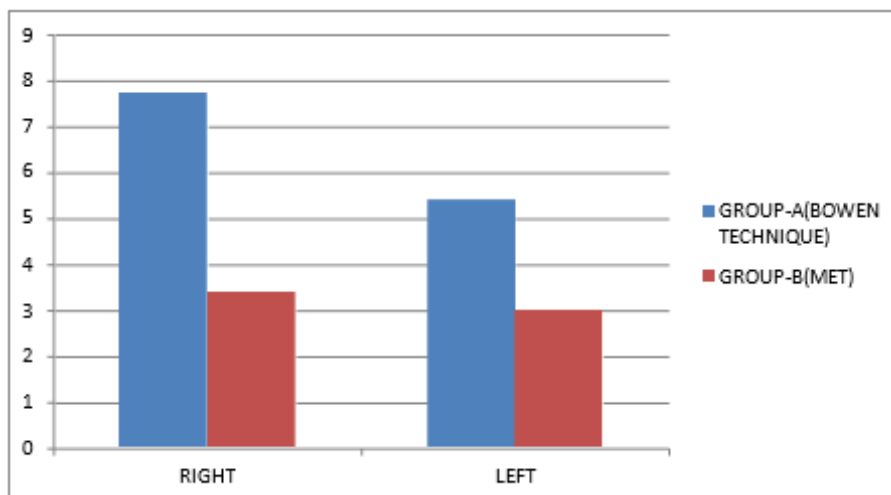


TABLE 4.1(b): MEAN DIFFERENCE BETWEEN GROUPA AND GROUPB OF RIGHT AND LEFT IN SIT AND REACH TEST

GROUPS	MEAN DIFFERENCE	
	RIGHT	LEFT
GROUP-A (BOWEN TECHNIQUE)	4.86	4.46
GROUP-B (MET)	2.13	2.06

FIG.4.1(b): MEAN DIFFERENCE BETWEEN GROUPA AND GROUPB OF RIGHT AND LEFT IN SIT AND REACH TEST

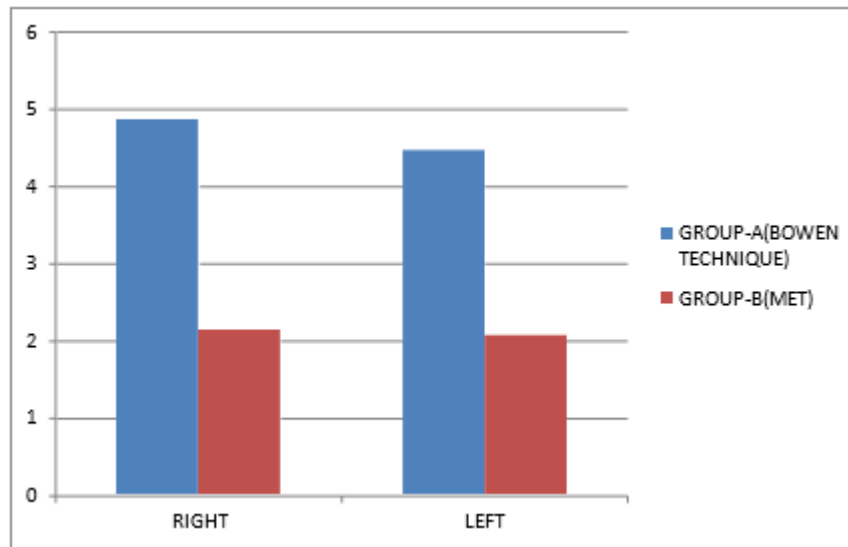


TABLE 4.2(a): STANDARED DEVIATION BETWEEN GROUPA AND GROUPB OF RIGHT AND LEFT IN POPLITEAL ANGLE

GROUPS	MEAN DIFFERENCE	
	RIGHT	LEFT
GROUP-A (BOWEN TECHNIQUE)	2.71	1.91
GROUP-B (MET)	1.47	1.81

FIG-4.2(a): STANDARED DEVIATION BETWEEN GROUPA AND GROUPB OF RIGHT AND LEFT IN POPLITEAL ANKLE

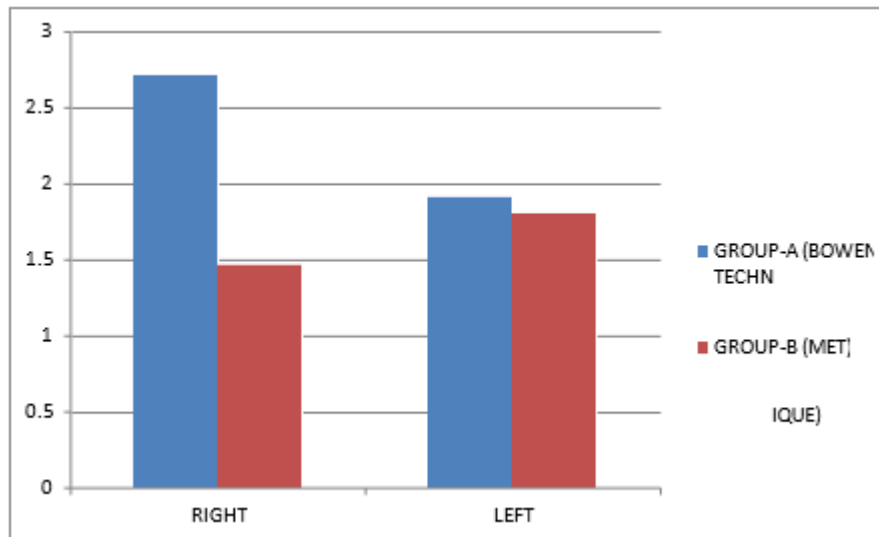


TABLE 4.2(b): STANDARED DEVIATION BETWEEN GROUPA AND GROUPB OF RIGHT AND LEFT IN SIT AND REACH TEST

GROUPS	STANDARED DEVIATION	
	RIGHT	LEFT
GROUP-A (BOWEN TECHNIQUE)	2.01	1.92
GROUP-B (MET)	1.22	1.10

FIG-4.2(b): STANDARED DEVIATION BETWEEN GROUPA AND GROUPB OF RIGHT AND LEFT IN SIT AND REACH TEST

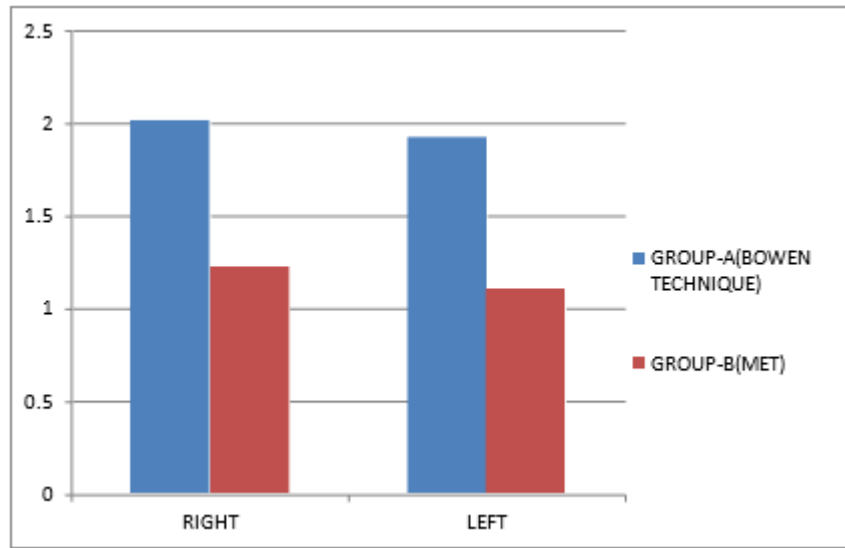


TABLE-4.3 (a): COMPARISON OF PAIRED ‘t’ TEST AND TABLE VALUE BETWEEN GROUP A AND GROUP-B OF RIGHTAND LEFT SIDEIN POPLITEAL ANGLE

GROUPS	CALCULATED PAIRED ‘t’ VALUE		TABLE VALUE	SIGNIFICANCE
	RIGHT	LEFT		
GROUPA (BOWEN TECHNIQUE)	11.02	10.50	2.15	SIGINIFICANT
GROUPB (MET)	8.90	6.41	2.15	SIGINIFICANT

FIGURE-4.3(a): COMPARISON OF PAIRED ‘t’ TEST AND TABLE VALUE BETWEEN GROUPA AND GROUPB OF RIGHT AND LEFT IN POPLITEAL ANGLE

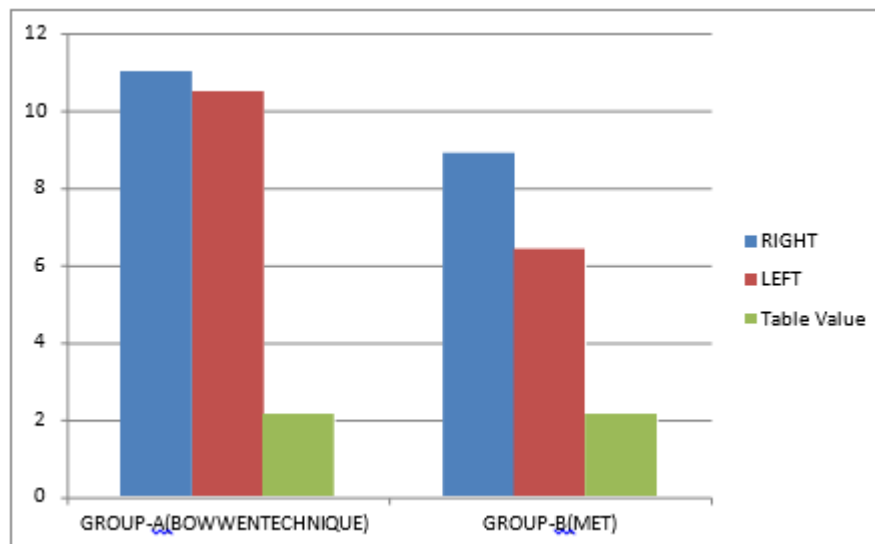


TABLE-4.3 (b): COMPARISON OF PAIRED ‘t’ TEST AND TABLE VALUEBETWEEN GROUPA AND GROUP-B OF RIGHT AND LEFT SIDE IN SIT AND REACH TEST

GROUP A (BOWEN TECHNIQUE)	CALCULATED PAIRED ‘t’ VALUE		TABLE VALUE	SIGNIFICANCE
	RIGHT	LEFT		
GROUP A (BOWEN TECHNIQUE)	9.3	8.9	2.15	SIGINIFICANT
GROUPB (MET)	6.7	7.8	2.15	SIGINIFICANT

FIGURE-4.3(b): COMPARISON OF PAIRED ‘t’ TEST AND TABLE VALUE BETWEEN GROUP A AND GROUP B OF RIGHT AND LEFT IN SIT AND REACH TEST

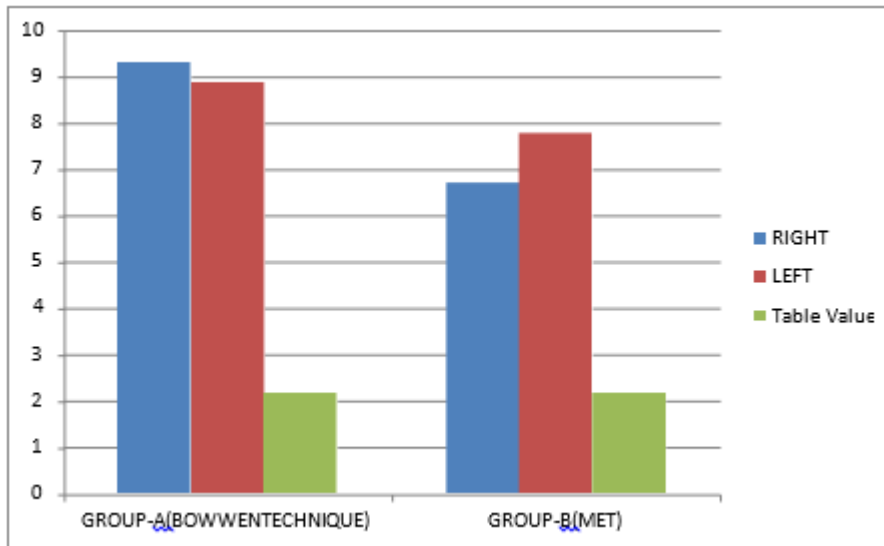


TABLE-4.4 (a): COMPARISON OF VALUES OF BOWEN’S & MET ON LEFT AND RIGHT SIDE UNPAIRED TEST IN POPLITEAL ANGLE

PARAMETERS	UNPAIRED ‘t’ TEST VALUE	TABLE VALUE	SIGNIFICANCE
GROUP- A(BOWEN TECHNIQUE)	5.72	2.05	SIGNIFICANT
GROUP-B(MET)	3.52	2.05	SIGNIFICANT

FIGURE-4.4(a): COMPARISON OF VALUES OF BOWEN’S& MET ON LEFT AND RIGHT SIDE UNPAIRED TEST IN POPLITEAL ANKLE

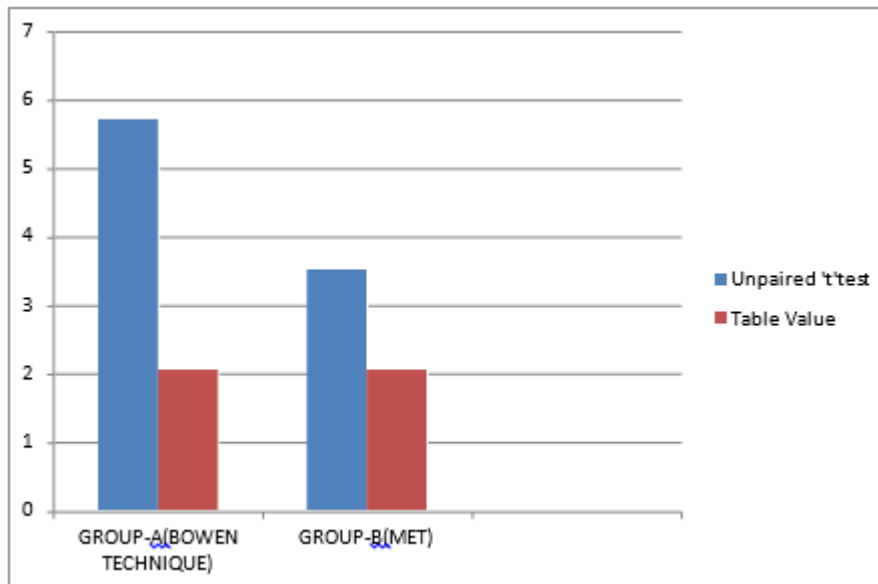
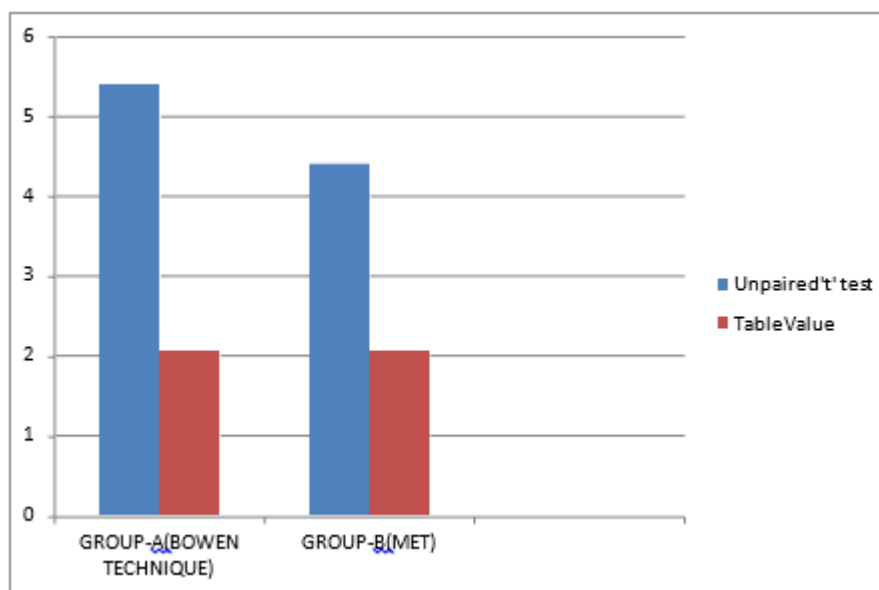


TABLE-4.4 (b): COMPARISON OF VALUES OF BOWEN’S & MET ON LEFT AND RIGHT SIDE UNPAIRED TEST IN SIT AND REACH TEST

PARAMETERS	UNPAIRED ‘t’ TEST VALUE	TABLE VALUE	SIGNIFICANCE
GROUP- A(BOWEN TECHNIQUE)	5.4	2.05	SIGNIFICANT
GROUP-B(MET)	4.4	2.05	SIGNIFICANT

FIGURE-4.4(b): COMPARISON OF VALUES OF BOWEN'S & MET ON LEFT AND RIGHT SIDE UNPAIRED TEST IN SIT AND REACH TEST

5. RESULTS

The study sample comprised 30 patients, of which 30 were males. The median time interval of goniometer and sit and reach test applied before and after therapy was 5 days. Among 30 patients, 15 were treated with bowen technique and 15 were treated with Muscle energy technique.

The pre and post test values were assessed in popliteal angle group A. The mean difference value in right side is 7.73 and left side 5.4. The standard deviation value in right side is 2.71 and left side is 1.91. The paired 't' test value for popliteal angle in right side 11.02 and left side 10.50. The paired 't' test value is more than table value 2.15 for 5% level of significance at 14 degrees of freedom.

The pre and post test values were assessed in popliteal angle group B. The mean difference value in right side is 3.4 and left side 3. The standard deviation value in right side 1.47 and left side 1.81. The paired 't' test value for sit and reach test in right side 9.32 and left side 1.9. The paired 't' test value is more than table value 2.15 for 5% level of significance at 14 degrees of freedom.

The pre and post test values were assessed in sit and reach test group B. The mean difference value in right side is 2.13 and left side 2.06. The standard deviation value in right side is 1.22 and left side is 1.10. The paired 't' test value for sit and reach test in right side 6.7 and left side 7.8. The paired 't' test value is more than table value 2.15 for 5% level of significance at 14 degrees of freedom.

The pre and post test values were assessed in sit and reach test group A. The mean difference value in right side is 4.86 and left side 4.46. The standard deviation value in right side 2.01 and left side 1.92. The paired 't' test value for sit and reach test in right side 9.32 and left side 8.97. The paired 't' test value is more than table value 2.15 for 5% level of significance at 14 degrees of freedom.

The calculated 't' values by unpaired 't' test were popliteal angle 5.72 and 3.52 and sit and reach test is 5.42 and 4.48. The calculated 't' values were more than the table value 2.05 for 5% level of significance at 28 degrees of freedom.

The paired 't' test values have shown that bowen technique was more

effective than muscle energy technique in symptomatic patients in hamstring tightness. The unpaired test values have shown that there was significant

difference between two groups in showing improvement in their quality of life in patients with hamstring tightness.

6. DISCUSSION

The present study was done to compare the effects of Bowen Technique and Muscle Energy Technique (MET) on asymptomatic subjects with hamstring tightness. An alternate day intervention was done for five days (three sessions) to

see which technique is more effective in increasing the flexibility of hamstring muscle in terms of popliteal angle and sit and reach test¹³.

There were 15 subjects in each group. The study comprised of subjects aged between 18-24 years in both the groups. Group A and Group B were given three sessions each for alternate days which lasted for a total of five days of treatment sessions¹⁴.

A study was conducted by Michelle Marro to see effects of Bowen Technique on hamstring flexibility over time concluded that a single treatment session with this technique significantly increased the flexibility of the hamstring muscle in asymptomatic individuals and also maintained this level of increase in hamstring flexibility for one week, showing continuing improvements.

After the application of Bowen Technique for three alternate sessions, showed significant improvements in hamstring flexibility in terms of sit and reach test and increase in range of motion in terms of popliteal angle¹⁵.

Muscle Energy Technique (MET) is a manual therapy technique, which targets the soft tissue primarily and can be called as Active Muscular Relaxation Technique¹⁶. It is a direct active post facilitating technique also known as Post- Isometric Relaxation Technique (PIRT), which follow different principles individually. It is a procedure in which controlled, voluntary isometric contractions of a target muscle group are widely advocated. It is effective for lengthening of shortened muscles, strengthening the muscle as lymphatic or venous pump to help drainage of fluids and for increasing range of motion (ROM)¹⁷. After Muscle Energy Technique there is viscoelastic change in muscle which helps in increasing muscle flexibility. After the application of muscle energy technique for three sessions alternately our study also showed significant improvement in the flexibility of hamstrings when measure with sit and reach test, increase in the range of motion was seen in the active knee extension test and significant increase was seen in the strength of the hamstring muscle.

Hence our study concluded that when Bowen Technique and Muscle Energy Technique are compared they both are equally effective in increasing the flexibility, range of motion and strength of the hamstring muscle when delivered for three sessions alternately.

It also concluded that Bowen Technique proved to be a little more effective than Muscle Energy Technique in terms of increase in the range of motion as it was a passive technique and the muscle was relaxed completely because of the moves and deep pressure applied by the therapist. But on the other hand, MET proved to be significantly effective in increasing the strength of the hamstring muscle because this technique was an active technique and the subject had to actively participate and apply his own strength against the therapist.

As per our knowledge, this is the first study which compared the effects of Bowen Technique and Muscle Energy Technique (MET) on hamstring tightness in healthy individuals with alternate three session intervention. Hence both the techniques can be used clinically to increase the flexibility and strength of the hamstring muscle.

LIMITATIONS

1. The study has been conducted on small size sample only.
2. This study took shorter duration to complete.
3. Age group taken for the study was limited (18-24years).

Recommendations

1. A similar study may be extended with larger sample.
2. The future study can be compared with various techniques also.
3. The Bowen Technique and Muscle Energy Technique can be applied to other muscles also.

7. CONCLUSION

On the basis of statistical analysis, we conclude that 3 sessions on alternate days for a week proved to be effective in improving popliteal angle, sit and reach test for flexibility and strength of muscle in both Bowen Technique as well as Muscle Energy Technique but Bowen Technique has shown more improvement in hamstring flexibility and ROM than Muscle Energy Technique. Increase in strength was seen more in Muscle Energy Technique than the Bowen technique. Since this study has given a better result in normal subjects it can be recommended for the use of the patients with hamstring tightness. This study analyses the immediate effect of hamstring flexibility, so the maintenance of flexibility of hamstring

muscle for long term can be done as a further study. These techniques can also be used for athletic population. Since this study recruited small number of subjects, the number of subjects can be increased in further studies.

REFERENCES

- [1] Divya G Patel*, Neeta J Vyas, Megha S Sheth “Immediate effect of application of bilateral self myo-fascial release on the plantar surface of the foot on hamstring and lumbar spine flexibility: a quasi experimental study”.
- [2] Sambandam, Cheraladhan E., Jagatheesan Alagesan, and Shilpi Shah. “Immediate effect of muscle energy technique and eccentric training on hamstring tightness of healthy female volunteers: A comparative study.” International Journal of current research and review 3.9(2011): 122-26.
- [3] Bandy, William D., Jean M. Irion, and Michelle Briggler. “The effect of static stretch and dynamic range of motion training on the flexibility of the hamstring muscles.” Journal of Orthopaedic & Sports Physical Therapy 27.4 (1998): 295-300.
- [4] Waseem, Mohd, Shibili Nuhmani, and Ram, C.S. “Efficacy of muscle energy technique on hamstring muscles flexibility in normal Indian collegiate males.” Calicut medical journal 7.2 (2009): e4.
- [5] Ahmed, Adel Rashad. “A comparative study of muscle energy technique and dynamic stretching on hamstring flexibility in healthy adults.” Bulletin of Faculty of Physical Therapy 16.1 (2011).
- [6] Marr, Michelle, et al. “The effects of the Bowen technique on hamstring flexibility over time: A randomised controlled trial.” Journal of bodywork and movement therapies 15.3 (2011): 281-290.
- [7] Ballantyne, Fiona, Gary Fryer, and Patrick Mc Laughlin. “The effect of muscle energy technique on hamstring extensibility: the mechanism of altered flexibility.” Journal of Osteopathic Medicine 6.2 (2003): 59-63.
- [8] Ayala, F., et al. “Reproducibility and criterion-related validity of the sit and reach test and toe touch test for estimating hamstring flexibility in recreationally active young adults.” Physical Therapy in Sport 13.4 (2012): 219-226.
- [9] Davis, D. Scott, et al. “Concurrent validity of four clinical tests used to measure hamstring flexibility.” The Journal of Strength & Conditioning Research 22.2 (2008): 583-588.
- [10] Bohannon, Richard W. “Test-retest reliability of hand-held dynamometry during a single session of strength assessment.” Phys Ther 66.2 (1986): 206-209.
- [11] Saeid Izad khah, Nasin Naseri, Nader Maarufi, Yashar Kocheili, Hashem Shabed in “Comparison of myofascial release and muscle energy technique effects on hamstring muscle flexibility”
- [12] Peeyoosha Nitsure¹, Neha Kothari² “The Effectiveness Of Bowen Technique As An Adjunct To Conventional Physiotherapy On Pain And Functional Outcomes In Subject With Acute Trapezitis – A Pilot Study”
- [13] Pramod K. Jagtap¹, Shubhangi D. Mandale “The effect of sub occipital muscle inhibition technique on Hamstring tightness patients”
- [14] Rahul Tanwar, Monika Moitra, Manu Goyal- “Effect of Muscle Energy Technique to Improve Flexibility of Gastro-Soleus Complex in Plantar Fasciitis: A Randomised Clinical, Prospective Study Design”
- [15] Jesudas Mazumdar; Jitendra Kumar Shriwas ;- “A Comparison Between Mulligan Traction Straight Leg Raise Technique Vs Muscle Energy Technique On Hamstring Tightness In A symptomatic Male” 13.4 (2012): 219-226