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Effect Of Isometric Exercises Using an Active Therapeutic Movement Device for Patients with Acute Low Back Pain

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ABSTRACT

Background: This study aimed to investigate the effects of isometric exercise using ATM®2 for acute low back pain (LBP) patients as a flexion or extension type.

Methods: The subjects were twenty individuals (age 39.7±8.0ys, 12 males / 8 females) with acute LBP of less than four weeks duration who volunteered to participate in the study. The participants were allocated into four groups. First, the participants were classified by the direction of the movement causing pain in flexion and extension types. Secondly, both types were allocated randomly into two groups which were given exercises using the ATM®2 group and the usual care group. Finally, both groups were treated three times weekly for two weeks, totaling six sessions.

Results: In terms of the extension type of LBP, the effect of the extension pain in the ATM®2-group significantly decreased pain (p=0.04) immediately. And in both groups significantly decreased (p=0.01, 0.001) for two weeks of intervention. Furthermore, in the flexion type of LBP, the effect of the flexion pain in the ATM®2-group and usual care group significantly decreased (p=0.001, p=0.03) during the two weeks intervention. However, neither group had an immediate effect.

Conclusion: Isometric exercise using ATM®2 may have an immediate and short-term effect on acute LBP, which is greater in patients with an extension-type pattern. The ATM®2 exercise may reduce the pain of the acute LBP. Furthermore, it will be a problem in the future to analyze if the influence of pain is reduced in the immediate natural period that gives to chronic LBP.

Keywords: Acute low back pain, isometric exercise, therapeutic exercise, ATM®2, visual analogue pain scores, Rolland-Morris disability Questionnaire.

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INTRODUCTION

Low back pain (LBP) is the most common musculoskeletal condition, with a lifetime prevalence of 17.5-30% [1]. Current prevalence is estimated to be 18.3%, and 1-month prevalence 30.8% [2]. Despite the frequency of LBP, a specific diagnosis can only be found in about 15% of cases [3]. The remaining cases are often referred to as non-specific LBP [4]. Non-specific LBP can be divided by the duration of symptoms with an acute duration of less than three months and a chronic duration greater than three months [5-6].

According to a recent systematic review, a number of conservative, non-medical treatments are effective for non-specific LBP, including manual or manipulative therapy, massage, acupuncture, psychological and mind-body interventions, multidisciplinary care, and various forms of exercise [7].

Additionally, the evidence suggests that the effectiveness of interventions differs for patients with acute and chronic LBP [8]. For example, local heat treatments and pharmacological therapies (NSAIDs, Muscle relaxants) are useful for patients with acute but not chronic LBP. On the other hand, behavioral treatment, multidisciplinary treatment, and some forms of exercise be effective for chronic but not acute LBP [4]. In particular, lumbar stabilization exercise [9-10] or a belt-like compressive device [11] are effective in patients with non-specific chronic LBP. However, the effectiveness of exercise therapy for acute low back pain suspected to be non-specific is not apparent.

The ATM®2 device was developed to treat pain and movement dysfunction in individuals with LBP by enabling them to perform specific therapeutic exercises. In particular, the ATM®2 device enables patients to perform strong isometric contractions in controlled positions and directions in standing.

There are some preliminary positive findings on the usefulness of ATM®2 in asymptomatic individuals. It is more effective than mat exercises in increasing lumbar ROM [12]. In patients with chronic LBP, Nejishima et al. [13] found that patients who received four weeks of treatment with the ATM®2 had improvements in pain and function (Rolland-Morris disability Questionnaire) immediately post-treatment and after four weeks of treatment. To date, no studies have investigated the effect of exercises using the ATM®2 on patients with acute LBP.

This pilot study aimed to compare the effect of isometric exercise using ATM®2 with usual care for patients with acute LBP. In particular, compare the change from baseline of 1) ROM and Visual Analogue (VAS) pain scores after one treatment session and 2) ROM, VAS, and a functional outcome measure after two weeks of treatment. A secondary aim for the treatment group was to determine if there were differences in ROM or VAS pain scores at either point related to the treatment direction.

METHODS

1. Participants

A controlled trial where participants with low back pain received either usual care (heat and traction) or usual care plus exercises with the ATM®2 three times per week for two weeks. Pain and range of motion (ROM) were measured before and after the first and final treatment. In addition, Roland Morris Questionnaire (RMQ) was evaluated before the first and after the last treatment.

Participants were recruited from patients with non-specific LBP who presented to one clinic where orthopedic specialists and physiotherapists were staffed. Twenty patients for 18 months were invited, and all agreed to participate in the study. The inclusion criteria were 1) low back pain without leg pain of less than four weeks duration and 2) pain with lumbar flexion and/or extension more significant than 30/100mm on VAS anchored, with zero being no pain and 100 being a pain that they could not endure. Exclusion criteria were 1) any specific diagnosis as a cause of their LBP such as fracture, other bony abnormality, tumor, or infection, and 2) factors that would prevent the participant from safely performing the exercise such as pregnancy or inflammatory conditions, 3) factors that may impact on their response to treatment such as psychological disorders, difficulty with communication in Japanese, a third party insurance claim, or taking any medication for their LBP.

A total of 20 participants (age: 39.7±8.4yr, height: 163.9±7.7cm, weight: 62.4±12.3kg) were recruited. Participants were classified by which direction of the movement was more painful. Ten were classified as having a flexion type and ten as an extension type pattern. Those with each type were alternately assigned to one of the two groups - exercises using ATM®2 and the usual care group (Table.1).

Table-1: Participants

	Flexion Type(n=10)		Extension Type(n=10)	
	Experimental (n=5)	Control (n=5)	Experimental (n=5)	Control (n=5)
Age	46.2 ± 12.0	38.8±8.4	37.8 ±5.3	35.8±3.7
Sex (M/F)	3/2	2/3	2/3	1/4
Height (cm)	162.8±7.0	160.4±4.8	163.4±9.2	168.8±8.6
Weight (kg)	63.2±13.4	59.6±13.9	58.2±6.7	68.6±14.9
BMI	23.8±4.3	23.0±4.0	21.8±1.3	23.8±3.7

BMI: Body Mass Index

All participants provided informed written consent before participation. Research Ethics Committee approved the study protocol at Seirei Christopher University (Approval number, 08045).

2. Intervention

All Participants in two groups received treatments three times per week for two weeks. The common treatment consists of heat therapy with a hot pack and traction

equivalent to half their body weight for 15 minutes. In addition, participants in the ATM®2 group also performed isometrics in the more painful direction of movement [12-13].

The use of the ATM®2 is shown in Figure 1. Participants stood either facing towards (extension) or away (flexion) from the pad on the device. Participants were stabilized with three belts, each at the height of the xiphoid process, anterior superior iliac spine, and the greater trochanter. The belts were tightened to be firm but not uncomfortable. A thoracic belt around the upper thorax was attached to the ATM®2 frame by a strap to provide resistance for the isometric contractions. The strap length was adjusted to ensure the exercise could be performed without pain. Participants crossed their hands behind their heads and performed maximum isometric contractions in the direction of flexion or extension.

Each participant performed ten cycles of contractions for three seconds, followed by seven seconds of rest. Exercises were performed three days per week for two weeks. Participants were requested not to do any other exercises or receive other treatment during the experimental period.

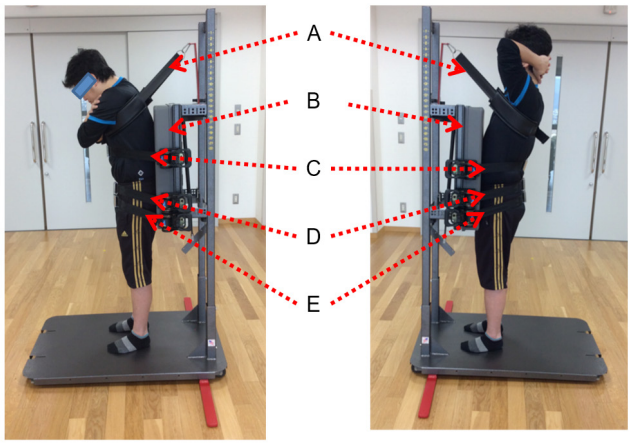

Figure-1: Implementation of ATM®2 with flexion direction shown on the left and extension on the right. Components are A) resistance belt, B) support pad, C) belt at level of xiphoid process, D) belt at anterior superior iliac spine, and E) belt at the greater trochanter.

3. Outcome measures

Measurements of pain and range of motion were taken 1) before treatment and 2) immediately after the first and after their final treatment. The pain at the trunk flexion and extension limit was evaluated using a VAS anchored as described above. In addition, RMQ was performed before the first and after the last treatment.

Flexion range of motion (ROM) was measured as the fingertip to floor distance in centimeters. Extension ROM was measured as the difference in the angle of the sternum from erect standing to full extension measured using an inclinometer (SHINWA Inc.).

4. Statistical Analyses

Between-group comparisons for each direction of Pain and ROM and RMQ were evaluated using repeated measures ANOVAs. The categorization of the participant (flexion or extension type) was included as an additional factor. Greenhouse-Geisser corrections were used when the assumption of sphericity was violated. The statistical significance was set at $p<0.05$. Statistical analysis was performed in SPSS for windows release12.0.

RESULTS

There were no significant differences between groups in the pre-test, except the VAS with flexion was higher in the experimental group than the usual care group ($p=0.01$) (Table 2). VAS in extension was also higher, but this did not reach statistical significance ($p=0.81$).

1. VAS

The changes in VAS over time are shown in Table 2. There was a significant within-subjects effect of time, with VAS reducing significantly at each of the three time points. No significant main effect of intervention was detected for movements into flexion, nor were any significant interactions found. For movements into extension, there was no main effect of the intervention. However, there was a significant main effect of type, with extension type participants improving more than flexion type. There was also a significant treatment group-by-type interaction with extension-type participants improving more in the treatment group immediately after the first treatment.

Table-2: Pain(VAS)

Pain- direction	Type	Pre-intervention		After 1st treatment		End of treatment	
		Experimental	Control	Experimental	Control	Experimental	Control
VAS in Flexion	Flexion	74.2 (14.9)	49.8 (7.8)	56.8 (13.2)	36.6 (18.8)	18.8 (22.6)	13.0 (12.1)
	Extension	51.8 (29.7)	38.4 (29.6)	31.0 (20.4)	35.6 (23.9)	10.8 (8.7)	14.8 (22.6)
	Total	63.0 (25.1)	44.1 (21.3)	36.1 (20.3)	43.9 (21.2)	13.9 (17.1)	14.8 (16.7)
VAS in Extension	Flexion	55.8 (17.7)	26.8 (14.0)	42.8 (13.8)	17.2 (14.1)	30.0 (18.9)	13.2 (7.1)
	Extension	75.6 (24.8)	67.8 (15.8)	30.4 (21.5)	58.4 (20.6)	44.4 (24.7)	6.6 (8.0)
	Total	65.7 (22.8)	47.3 (25.8)	36.6 (18.2)	37.8 (27.4)	37.2 (22.6)	9.9 (8.0)

2. ROM

The changes in ROM over time are shown in Table 3. ROM increased significantly at each time point for both flexion and extension, but there were no significant main effects or interactions.

Table-3: ROM

Mobility	Type	Pre-intervention		After 1st treatment		End of treatment	
		Experimental	Control	Experimental	Control	Experimental	Control
Trunk Flexion	Flexion	27.9 (28.1)	17.0 (20.6)	24.2 (24.8)	7.4 (10.3)	6.2 (12.7)	3.1 (6.3)
	Extension	24.0 (11.2)	30.4 (11.6)	25.4 (13.2)	33.6 (12.2)	36.2 (7.5)	35.0 (16.3)
Trunk Extension	Flexion	11.5 (7.6)	12.7 (15.4)	3.6 (8.6)	7.1 (11.7)	5.2 (4.7)	2.5 (5.6)
	Extension	31.2 (16.6)	19.8 (7.7)	38.2 (13.7)	24.4 (11.8)	41.0 (6.2)	35.6 (12.8)

3. RMQ

The pre and post-treatment scores on the Roland Morris Questionnaire are shown in Table 4. RMQ improved between the two-time points. No significant differences were detected between groups, nor was any difference related to the more painful direction of movement.

Table-4: RMQ

Type	Pre-intervention		End of treatment	
	Experimental	Control	Experimental	Control
Flexion	27.9 (28.1)	17.0 (20.6)	6.2 (12.7)	3.1 (6.3)
Extension	24.0 (11.2)	30.4 (11.6)	36.2 (7.5)	35.0 (16.3)

DISCUSSION

This study aimed to investigate the effect of isometric exercise using ATM®2 on patients with acute LBP. There was a significant improvement in pain and ROM at each time point regardless of group allocation. Moreover, pain in the extension for extension-type participants significantly improved more in the treatment group than in the usual care group. In particular, the only significant effect of ATM®2 was the change in pain during extension movements after the initial treatment. A previous study suggested that exercise with the ATM®2 device improved patients with chronic LBP [13]. However, the effect on acute low back pain was not apparent. Effective in treating acute low back pain is a novelty.

The precedent study reported the effects of the therapeutic exercise, which reduced the pain compared to conservative therapy of acute LBP did not have a difference [14]. On the contrary, some evidence is that the McKenzie method is more effective than passive therapy, including educational booklets, ice packs, and massage for acute LBP [15]. Exercises using ATM®2 have similarities to the Mackenzie method in that each involves specific repeated movements performed by the patient. The differences are that with the ATM®2, the patient performs maximum isometric contractions with minimal movement. In contrast, in the McKenzie approach, the patient performs repeated end-of-range movements with minimal muscle contraction.

Furthermore, the exercise using ATM®2 was similar to the Mackenzie method in that it was performed under conditions that did not cause pain. After all, we thought performing a therapeutic exercise effective in controlling the pain to an acute LBP was effective. These findings suggest that exercise therapy with pain control is more effective in acute LBP.

Two weeks after the present results, both the ATM®2 group and the control group reduced pain in the same direction for both extensor and flexor types. Therefore, the effect of exercise with ATM®2 was not clear. The natural history of LBP has been found to improve by approximately 58% at four weeks [16]. Therefore, most of the improvements found in the current study may not have been related to usual care or the ATM®2 being effective but simply due to the natural course of LBP. It is also possible that the significant results found in the current study may be a statistical anomaly. Although the baseline difference in VAS in Extension between the groups was not large enough to be significant, the more remarkable change after the first treatment in the experimental group may have represented a regression toward the mean.

This study using the ATM®2 device had heterogeneous populations and small sample sizes, so it was underpowered to detect small to moderate effects. For example, in the current study, a post-hoc power analysis [17] indicated an effect size of 0.75 would be necessary before a power of 0.80 could be achieved. This would mean that the sample size used in the current study would only have reasonable power to detect a difference between groups more significant than 15/100mm on a VAS scale. As a comparison, in a meta-analysis of the effect of exercise interventions, Hayden et al. [18] found the pooled weighted improvement following exercise to be about 10/100mm when compared with no treatment and less than 6/100mm when, as in the current study, the exercise was compared with other interventions. In addition, a few studies investigating the McKenzie method demonstrated differences in pain of approximately 20/100mm on a VAS scale either in favor of McKenzie or an alternative treatment. Such effect sizes would have been large enough to be detectable in the current study [15]. A meta-analysis indicated an overall difference of approximately 6/100mm when the McKenzie approach was compared with other active treatments. This is similar to what was found for other types of exercises. In summary, the effect size for treatment by the ATM®2 would have needed to have been more than twice as large as those found for other exercise interventions for the current study to be adequately powered.

CONCLUSION

The only significant difference between the treatment and usual care groups was an immediate reduction in pain with extension in the extension type. However, it was underpowered to detect the size of the difference that might be expected when comparing two active treatments.

Future research may clarify whether selecting the direction of treatment with the ATM®2 according to patient response rather than the more limited direction would be more effective. Nevertheless, the modest results in this low-powered pilot study may be sufficient to justify further research into ATM®2 as a treatment modality for people or subgroups of people with acute low back pain.

REFERENCES

[1] James SL, Abate D, Adate KH, Abbafati C, Murray CJL. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018; 392 (10159):1789-1858.

[2] Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, et al. A systematic review of the global prevalence of low back pain. Arthritis Rheum. 2012; 64(6):2028-

2037.
[3] Deyo RA, Rainville J, Kent DL. What can the history and physical examination tell us about low back pain? JAMA. 1992; 268(6):760-765.
[4] Maher C, Underwood M, Buchbinder R. Non-specific low back pain. Lancet. 2017; 389(10070):736-747.
[5] Dionne CE, Dunn KM, Croft PR, Nachemson AL, Buchbinder R, Walker BF, et al. A consensus approach toward the standardization of back pain definitions for use in prevalence studies. Spine. 2008; 33(1):95-103.
[6] Van Tulder M, Becker A, Bekkering T, Breen A, del Real MT, Hutchinson A, et al. Chapter 3. European guidelines for the management of acute non-specific low back pain in primary care. Eur Spine. 2006; J15, Suppl 2: S169-91.
[7] Chou R, Huffman LH. Nonpharmacologic therapies for acute and chronic low back pain: a review of the evidence for an American Pain Society/American College of Physicians clinical practice guideline. Ann Intern Med. 2007; 147(7):492-504.
[8] Rubinstein SM, van Middelkoop M, Assendelft WJ, de Boer MR, van Tulder MW. Spinal manipulative therapy for chronic low-back pain: an update of a Cochrane review. Spine. 2011; 36(13):E825-46.
[9] Moon HJ, Choi KH, Kim DH, Kim HJ, Cho YK, Lee KH, et al. effect of lumbar stabilization and dynamic lumbar strengthening exercises in patients with chronic low back pain. Ann Rehabil Med. 2013; 37(1):110-117.
[10] Kumar T, Kumar S, Nezamuddin M, Sharmadet VP. Efficacy of core muscle strengthening exercise in chronic low back pain patients. J Back Musculoskelet Rehabil. 2015; 28(4):699-707.
[11] Ogura H, Kihara T, Gamada K. Effect of exercise program using a pelvic and thoracic realignment device in care workers with low back pain. Physiotherapy. 2015; 101:e435-e6.
[12] I to K, Gamada K. The Immediate Effects of Therapeutic Exercise using the ATMR2 on Trunk and Hip Range of Motion of Healthy Male Individuals: A Randomized Controlled Study. Rigakuryoho kagaku. 2014; 29(5):735-738.
[13] Nejishima M, Sugiura T, Kubo Y, Kobori K, Gamada K, Yokoyama S, et al. The Effect of an Exercise using an Active Therapeutic Movement Device on Mechanical Low Back Pain: A Case Series Study. Rigakuryoho Kagaku. 2010; 26(2): 225-230.
[14] Antti V, Malmivaara B, W Koes: Meta-analysis: therapeutic exercise for non-specific lower back pain. Ann Intern Med. 2005; 142: 765-775.
[15] Machado LA. The McKenzie method for low back pain; a systematic review of the literature with a meta-analysis approach. Spine. 2006; 31(9):E254–E262.
[16] Pengel LH, Herbert RD, Maher CG, Refshauge KM. Acute low back pain: systematic review of its prognosis. BMJ. 2003; 327(7410):323.
[17] Faul F, Erdfelder E, Buchner A, Lang AG. Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. Behav Res Methods. 2009; 41(4):1149-1160.
[18] Hayden JA, van Tulder MW, Malmivaara A, Koes BW, Exercise therapy for treatment of non-specific low back pain. Cochrane Database Syst Rev. 2005; CD000335.