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ORIGINAL ARTICLE

The effects of lumbar self-sustained natural apophyseal glides on lumbar spine range of motion and hip muscle flexibility in asymptomatic college students: a crossover study

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ABSTRACT

Background: Patients with low back pain (LBP) tend to have prolonged treatment periods, which increase the cost of medical care. Several studies have reported that lumbar spine range of motion (ROM) and hip muscle flexibility are factors in LBP. Sustained natural apophyseal glides (SNAGs) have reportedly improved the lumbar spine ROM and hip flexibility of LBP patients. Moreover, self-SNAGs can be performed by the patients themselves.
Aim: This study aimed to evaluate the short-term effects of self-SNAGs on lumbar spine ROM compared to a repeated movement procedure in asymptomatic college students.
Methods: A prospective crossover study was conducted on 14 asymptomatic male college students. The asymptomatic participants performed self-SNAGs or repeated movements (i.e., three sets per day, 6 times a day over 1 week), and the compliance rate for both exercises was recorded. The lumbar spine ROM (i.e., flexion, extension, lateral bending, and rotation) was measured using the back ROM instrument, and hip muscle flexibility was measured using the Thomas test, heel-buttock distance, finger-floor distance, and straight leg raise test (SLR). Measurements were taken before commencement, immediately after, and 1 week later.
Results: Left lateral bending and left SLR were excluded from the between-group comparison (self-SNAG and sham) due to a carryover effect ($P < 0.05$). A comparison between the self-SNAG and sham groups displayed no significant differences in the lumbar spine ROM and hip muscle flexibility ($P > 0.05$).
Conclusion: Our study revealed that lumbar self-SNAGs had no significant effect on lumbar spine ROM or hip muscle flexibility in the short term, suggesting that such movements should be avoided when stretching to prevent LBP. However, this study did not include subjects with limited lumbar spine ROM and hip muscle flexibility due to pain, warranting further validation in future studies.
Relevance for Patients: The effects of lumbar self-SNAGs were similar to that of sham exercises in healthy individuals without joint ROM restrictions in the trunk or lower extremities due to LBP.

1. Introduction

Low back pain (LBP) is expected to develop in approximately 75.6% of adults at some point in their lives [1,2], and the recovery period is a significant financial burden even in developed countries [3-5]. LBP is commonly associated with decreased mobility of the lumbar spine [6-8], that is, decreased muscle flexibility around the trunk and hip joints [9-13]

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and the lumbar spine range of motion (ROM) [8]. Nonetheless, the causative factors (e.g., physical and functional) of LBP should be considered during the treatment process.

LBP is commonly treated with conservative management, which includes management exercise and manual therapy [14]. Among the different forms of manual therapy, mobilization with movement (MWM), devised by New Zealand physiotherapist Brian Mulligan [15,16], could effectively reduce pain and increase ROM at the affected joints of patients. A sustained natural apophyseal glide (SNAG) is an MWM technique that encourages the patient to move in a painful restricted direction. At the same time, the therapist applies a specific force to the spine through the spinous process in a direction parallel to the facet joint plane [17-26]. The applied force could subsequently eliminate pain during movement, and the pressure on the spinous process should be adjusted according to the patient's symptomatic response to the SNAG procedure to encourage more movements. This process is typically performed in three sets for 6–10 times [15,16].

Following a SNAG procedure, the patient is prescribed a self-SNAG as a home exercise to maintain or improve the pain-free ROM. A self-SNAG is essentially the same as the conventional SNAG technique, but it is performed solely by the patient. The manual force is applied to the spine by placing a thin strap under the spinous process of the affected area and applying cranial inclined pressure through the strap along the plane of the facet joint. With the force maintained by the strap, the patient repeats the active lumbar spine movement.

Previous studies have examined the effects of lumbar SNAGs in people with and without LBP with varying results [19,20,22]. Studies have been conducted to compare the effectiveness of manual therapy interventions on ROM in asymptomatic participants [27,28]. While SNAGs have reportedly improved ROM and flexibility [21], the effectiveness of self-SNAGs has not been reported, warranting further investigations in this regard.

Herein, we evaluated the effectiveness of self-SNAGs in healthy subjects based on their lumbar ROM and lower body flexibility. The purpose of this study was to compare the short-term effectiveness of lumbar self-SNAG with conventional trunk flexion in asymptomatic college students in terms of lumbar ROM and hip flexibility. We hypothesized that self-SNAGs could effectively increase patient compliance and subsequent improvements in LBP.

2. Methods

2.1. Participants

This study was registered in the University Medical Information Network (UMIN) Clinical Trials Registry (UMIN000040313). This study was approved by the ethics committee at the Saitama Medical University (929) and conducted in accordance with the Declaration of Helsinki. All participants agreed to sign an informed consent form.

Participants were recruited by means of advertising using posters placed across Saitama Medical University. We included 14 participants for the present study (average age: 21.0 ± 0.8 years; average height: 170.3 ± 4.3 cm; and average weight: 70.5 ± 13.3 kg). Participants were excluded if no consent was provided, if they had a history of LBP within the past 2 years, or could not perform the self-SNAG exercise. The study was a prospective randomized double-blinded crossover controlled study investigating the effect of self-SNAGs on lumbar spine ROM in asymptomatic college students.

2.2. Protocol

Each participant performed a warm-up, consisting of lumbar flexion, extension, lateral bending, and rotation movements that were performed 3 times in each movement direction. In this crossover study, different exercises were performed in Phases I and II. The envelope method was used to randomly allocate participants to either group A or B. In Phase I, Group A performed self-SNAG, while Group B performed the conventional trunk flexion. In the self-SNAG group (Group A), a specifically designed mobilization strap was hooked under the spinous process of the L4 lumbar with applied force in the cranial direction using both arms. While this force was maintained, the subject moved into trunk flexion as far as possible in the absence of pain (Figure 1A). The sham group performed repeated trunks forward as far as possible in the absence of pain without the strap (Figure 1B). The elbow and knee joints were flexed during the procedure. Both groups of subjects returned to their starting position immediately after flexing the lumbar spine. The exercises were performed in three sets 6 times/day over 1 week. The participants were requested to record the time of exercises on a specific table provided to them to evaluate the compliance rate. In Phase II, the exercises in Phase I were crossed over so that Group A performed the conventional trunk flexion while Group B performed the self-SNAG. The frequency of warm-ups and exercises and the evaluations were performed similarly to Phase I. The participants were instructed to record each exercise on a designated form daily for 1 week.

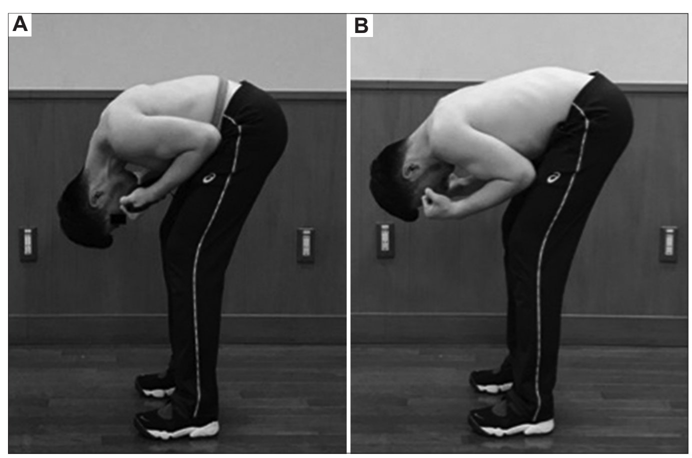

Figure 1. Exercises performed in the study. (A) In the self-sustained natural apophyseal glides group, the participants hooked a strap to the L4 spinous process and performed forward trunk flexion. (B) In the sham group, participants performed repeated forward trunk flexion without the strap.

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2.3. Measurement of the lumbar spine ROM

Measurements were taken before, immediately after, and 1 week after each exercise was performed. A back ROM (BROM) instrument (BROM Performance Attainment Associates, USA) was used on the twelfth thoracic spinous process for lumbar spine ROM measurement (Figure 2) [27,28]. ROM measurement was performed 3 times in each direction (i.e., flexion, extension, lateral bending, and rotation). The mean of three measurements was used for data analysis.

2.4. Other measurements

The Thomas test was performed on the participants in the supine position. The participant had one side of the hip joint maximally flexed, while the other side was extended. When the extended limb started to flex, the contralateral hip flexion angle was measured using an electrogoniometer with a minimum unit of 0.1°. The heal-buttock distance (HBD) was assessed with the subject in the prone position. The participant's knee was maximally flexed until firm resistance was observed. The distance between the heel and the buttocks was measured in mm. The finger-floor distance (FFD) was assessed in the standing position, and the participants were instructed to flex forward and maximally reach for the toes with their fingertips while maintaining the knees in extension. The distance between the fingertips and the floor was measured with a ruler in mm. The straight leg raise test (SLR) was evaluated with the subject in the supine position. The hip joint was flexed while maintaining the participant's knee joint in extension, and the range of hip flexion was recorded in degrees using an electrogoniometer. The mean of three measurements was used for data analysis.

2.5. Data analysis

All data were analyzed with SPSS Version 27.0 (IBM Corporation, USA). Either an unpaired *t*-test or Mann-Whitney *U* test was used to compare the effects in Phase I and performed both immediately and 1 week after intervention (i.e., self-SNAG or repeated movement). Likewise, either a paired *t*-test or Wilcoxon rank sum test was used to determine whether the intervention effect in Phase I was washed out and was performed based on the baseline values of Phases I and II. If the intervention effect of Phase I was washed out, we compared the intervention effect both immediately and 1 week after intervention between the self-SNAG (n = 14) and sham (n = 14) groups using an unpaired *t*-test or Mann–Whitney U test. If the intervention effect of Phase I was not washed out, the endpoint was excluded from this study. Significant differences were set at a level of 0.05.

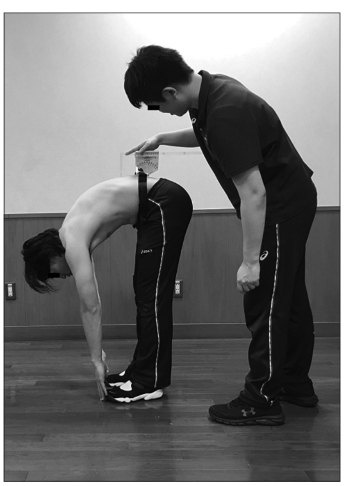

Figure 2. Measurement of the lumbar spine flexion range of motion (ROM) using a back ROM instrument.

3. Results

Our findings revealed that the compliance rate for performing the exercises over the 1-week intervention period in the self-SNAG and sham groups was 95%. We observed no significant differences in the exercise compliance rate between the groups both immediately and 1 week after Phase I intervention ($P > 0.05$).

However, there was a significant difference in left lateral bending and left SLR in group B for the pre-intervention comparison of Phases I and II (Tables 1 and 2). Therefore, lateral bending and left SLR were deemed as washed out and were excluded from the study.

In Phase I, self-SNAG was performed in Group A, and conventional trunk flexion was performed in Group B. Subsequently in Phase II, the exercises in Phase I were replaced, where Group A performed conventional trunk flexion and Group B performed self-SNAG. The difference in averages (of lumbar ROM and other measurements) between both groups in Tables 1 and 2, respectively, are expressed as mean ± standard deviation.

In addition, we observed no significant differences in the lumbar ROM (i.e., flexion, extension, right lateral bending, and rotation) and other measurements (Thomas test, HBD, FFD, and right SLR test) both immediately and 1 week after intervention (Tables 3 and 4, respectively).

Table 1. Differences in the lumbar ROM for Groups A and B between Phases I and II

Group	Measurement	Difference	*P*-value	95% CI
A (*n*=4)	Flexion	2.3±3.3	0.26†	−2.97, 7.47
	Extension	2.4±1.8	0.45‡	N/A
	Right lateral bending	1.2±2.1	0.35†	−2.23, 4.56
	Left lateral bending	1.7±3.5	0.41†	−3.85, 7.18
	Right rotation	−1.3±2.1	0.32†	−4.56, 2.06
	Left rotation	0.0±0.9	1.00†	−1.50, 1.50
B (*n*=10)	Flexion	1.8±4.5	0.24†	−1.44, 5.04
	Extension	3.1±0.2	0.57‡	N/A
	Right lateral bending	−0.8±3.0	0.43†	−2.98, 1.38
	Left lateral bending	−2.1±1.8	0.01†	−3.48, −0.79
	Right rotation	−1.2±2.2	0.12†	−2.80, 0.40
	Left rotation	−1.1±2.0	0.12†	−2.47, 0.34

Note: †*P*-value was determined via student's *t*-test; ‡*P*-value was determined via Wilcoxon rank sum test.
Abbreviations: CI: Confidence interval; N/A: Not applicable; ROM: Range of motion.

4. Discussion

The purpose of this study was to evaluate the effects of self-SNAGs compared to conventional repeated movements (i.e., trunk flexion) on the lumbar spine ROM and hip muscle flexibility both immediately and 1 week after intervention.

Table 2. Differences in the other measurements for Groups A and B between Phases I and II

Group	Measurement	Difference	*P*-value	95% CI
A (*n*=4)	Right-side Thomas test	0.6±0.8	0.26†	−7.00, 1.80
	Left-side Thomas test	0.2±0.9	0.52†	−0.47, 0.85
	Right HBD	−0.1±0.4	0.97†	−0.71, 0.69
	Left HBD	0.1±1.5	0.86†	−0.96, 1.13
	FFD	−4.0±13.8	0.60†	−25.98, 17.98
	Right SLR	−7.8±21.5	0.28†	−23.23, 7.57
	Left SLR	−7.0±15.4	0.43†	−31.58, 17.58
B (*n*=10)	Right-side Thomas test	−10.5±19.7	0.13†	−24.53, 3.60
	Left-side Thomas test	−55.8±112.5	0.39†	−234.83, 123.16
	Right HBD	−15.9±26.3	0.88†	−34.72, 2.92
	Left HBD	70.9±10.3	0.14‡	N/A
	FFD	66.6±6.5	0.80‡	N/A
	Right SLR	71.6±11.8	0.07‡	N/A
	Left SLR	67.0±10.1	0.05‡	N/A

Note: †*P*-value was determined via student's *t*-test; ‡*P*-value was determined via Wilcoxon rank sum test.
Abbreviations: CI: Confidence interval; HBD: Heel-buttock distance; FFD: Finger-floor distance; SLR: Straight leg raise test; N/A: Not applicable.

For lumbar spine ROM (flexion, extension, right lateral bending, and rotation), no intervention effect was observed either immediately or 1 week after the intervention. Although no studies have previously investigated the effects of self-SNAGS, studies on the effects of lumbar SNAGs in asymptomatic participants have also reported no significant differences in lumbar spine ROM [26]. Taken together, both SNAG and self-SNAG do not affect the ROM of pain-free people, suggesting that SNAGs target pain through a different mechanism instead of the lumbar ROM *per se*. In symptomatic people with LBP, a pain-free mobilization force applied during the self-SNAG or SNAG procedure is thought to improve the gliding property of the facet joints [19], thereby reducing pain and the fear of movement during exercise. Since the participants of this study were asymptomatic, the lumbar ROM was not restricted by pain and could only improve through changes in the viscoelastic properties of the joints and soft tissue. However, there were no significant differences between the sham and self-SNAG procedures.

Similarly, there were no changes to muscle flexibility around the trunk and pelvis following the application of self-SNAGs. The Thomas test, HBD, FFD, and right SLR reported no intervention effect both immediately and 1 week after the intervention. In a previous study, SNAGs were performed on the lumbar spine of LBP participants in combination with trunk flexion, and the findings revealed improvements in the flexibility of the back and hip muscles [22]. In addition, the stiffness of the multifidus and erector spinae muscles (after SNAGs) was measured using shear wave elastography and reported a decrease in muscle hardness,

Table 3. Lumbar spine range of motion measurements immediately and 1 week after intervention

Intervention time	Measurement	Group	Lumbar spine range of motion				
			Mean±SD	*P*-value	95% CI	Effect size	Power (1–β)
Immediately after	Flexion	Self-SNAGs	10.5±3.0	0.66§	−3.17, 2.03	0.15	0.07
		Sham	11.0±3.6				
	Extension	Self-SNAGs	4.6±2.8	0.95	N/A	0.00	0.05
		Sham	4.6±3.2				
	Right lateral bending	Self-SNAGs	26.8±3.8	0.12§	−0.58, 5.01	0.62	0.35
		Sham	24.6±3.3				
	Right rotation	Self-SNAGs	8.6±2.6	0.25§	−0.92, 3.40	0.47	0.23
		Sham	7.3±2.9				
	Left rotation	Self-SNAGs	9.0±2.9	0.10§	−0.34, 3.96	0.65	0.38
		Sham	7.2±2.6				
One week after	Flexion	Self-SNAGs	9.6±2.7	0.50§	−3.50, 1.74	0.27	0.11
		Sham	10.5±3.9				
	Extension	Self-SNAGs	4.4±2.0	0.54	N/A	0.33	0.13
		Sham	5.2±2.8				
	Right lateral bending	Self-SNAGs	25.6±3.4	1.00	N/A	0.17	0.07
		Sham	25.0±3.6				
	Right rotation	Self-SNAGs	8.0±3.1	0.55§	−1.71, 3.14	0.26	0.10
		Sham	7.2±3.1				
	Left rotation	Self-SNAGs	8.4±2.4	0.30§	−1.00, 3.10	0.41	0.18
		Sham	7.3±2.9				

Note: §*P*-value was determined via the unpaired *t*-test; *P*-value was determined via the Mann-Whitney U test.
Abbreviations: SD: Standard deviation; CI: Confidence interval; SNAGs: Sustained natural apophyseal glides; N/A: Not applicable.

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Table 4. Other measurements immediately and 1 week after intervention

Intervention time	Measurement	Group	Measurement				
			Mean±SD	*P*-value	95% CI	Effect size	Power (1–β)
Immediately after	Right-side Thomas test	Self-SNAGs	3.8±1.0	0.21§	−0.68, 0.52	0.82	0.55
		Sham	4.5±1.7				
	Left-side Thomas test	Self-SNAGs	4.0±1.5	0.93§	−1.17, 1.07	0.03	0.05
		Sham	4.1±1.4				
	Right HBD	Self-SNAGs	90.9±37.1	0.94§	−33.81, 31.38	0.05	0.05
		Sham	92.1±46.3				
	Left HBD	Self-SNAGs	91.5±41.9	0.97§	−35.07, 33.79	0.82	0.55
		Sham	92.2±46.6				
	FFD	Self-SNAGs	−8.1±111.2	0.89§	−85.80, 75.04	0.03	0.05
		Sham	−2.7±95.2				
	Right SLR	Self-SNAGs	68.7±6.3	0.43	N/A	0.05	0.05
		Sham	67.1±6.1				
One week after	Right-side Thomas test	Self-SNAGs	3.8±1.2	0.87§	−0.08, 0.47	0.92	0.65
		Sham	3.8±1.3				
	Left-side Thomas test	Self-SNAGs	4.2±1.3	0.91§	−1.16, 1.30	0.30	0.12
		Sham	4.1±1.8				
	Right HBD	Self-SNAGs	79.1±33.3	0.43§	−39.56, 17.46	0.02	0.05
		Sham	90.1±39.8				
	Left HBD	Self-SNAGs	82.9±37.7	0.64§	−37.02, 23.17	0.92	0.65
		Sham	89.8±39.7				
	FFD	Self-SNAGs	1.5±86.7	0.96§	−69.38, 65.62	0.30	0.12
		Sham	3.4±87.1				
	Right SLR	Self-SNAGs	68.1±4.6	0.53§	−2.61, 4.95	0.02	0.05
		Sham	67.0±5.2				

Note: §*P*-value was determined via the unpaired *t*-test; *P*-value was determined via the Mann–Whitney U test.
Abbreviations: SD: Standard deviation; CI: Confidence interval; SNAGs: Sustained natural apophyseal glides; N/A: Not applicable; HBD: Heel-buttock distance; FFD: Finger-floor distance; SLR: Straight leg raise test.

which could be attributed to the presence of pain [29]. Pain is likely to increase the muscle tone of the muscles around the spine and pelvis which influences flexibility [30]. The effectiveness of SNAG in improving flexibility and reducing pain is influenced by the subject's initial flexibility limitations and pain intensity. In addition, the accuracy of the technique and the duration of the intervention may have an impact. It may be difficult to determine the effect of treatment in patients with milder symptoms. Notably, it is unclear whether SNAG practitioners are members of the Mulligan Concept Teacher Association or Certified Mulligan Practitioners, or whether their skills in performing SNAGs are well established. Furthermore, patients would display a poorer compliance rate at longer intervention periods or when their symptoms started to improve, thereby affecting the effectiveness of the study. The elimination of pain through the SNAG technique, together with repeated active movement, could explain the improvement in muscle flexibility. In the absence of pain, repeated movement with or without the self-SNAG appears to have no beneficial effect on muscle flexibility. Despite our results indicating that self-SNAG did not affect lumbar ROM and hip muscle flexibility, previous studies have suggested that it could alleviate pain.

Moreover, the lack of effect observed in this study could be attributed to the different positions used in previous SNAG studies. The self-SNAG procedure in this study was performed in a standing position, while SNAGs were performed in a sitting position in previous studies, of which demonstrated positive effects [19-21,24-26]. The different effects between our study and previous reports could also be associated with the force generated by an experienced therapist for SNAG versus a self-SNAG where the force relies on the lumbar self-SNAG strap (typically lesser than that applied by the therapist's hands in a regular SNAG), suggesting that self-SNAGs may be less effective in increasing muscle flexibility of the lower limbs when compared to SNAGs and warranting further investigation in a symptomatic population. Our study also demonstrated a carryover effect in left lateral bending and left SLR. Although we did not examine the dominant arm in this study, we hypothesized that right-handed subjects tended to pull harder on the right strap, strongly affecting the left lumbar rotation and left SLR and resulting in longer-lasting effects.

This study also compared the effects of lumbar spine flexion, extension, right lateral flexion, right rotation, and left rotation ROM, and the Thomas test, FFD, and right SLR exhibited a trend toward higher lumbar spine ROM or hip muscle flexibility immediately after intervention. This study was based on a crossover study in which manual therapy [31,32] and myofascial release [33] were performed on LBP participants, and a 1-week

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washout was established after no significant differences were observed. Hatano *et al.* [32] reported that the effect of 300 s of static stretching was equivalent to 20 min of static stretching. Therefore, it is suggested that regular stretching by a therapist and continued stretching are important to sustain the effects of the intervention. However, LBP has a high incidence rate and is expensive to treat [34], making it difficult for patients to visit the clinic regularly. Nonetheless, the duration of treatment for LBP can be shortened when the compliance rate of self-exercise is high [34]. However, in this study, the self-SNAGs and sham groups displayed a decreasing trend in efficacy 1 week after the intervention compared to immediately after the intervention, even though the compliance rate was 95% for both groups. This could be due to the fact that the self-exercise for evaluating the intervention effects immediately after the intervention was performed under the supervision of the researchers, whereas the self-exercise for the comparison of intervention effects 1 week after the intervention was performed at home and unsupervised. Nicolson *et al.* [35] reported that the correct implementation of the self-exercise overestimates the intensity and frequency of the exercises. When performing self-SNAGs at home, it is unclear whether the subject can apply the belt in the correct position, pull the belt with the correct force, and balance the left and right sides of the belt as instructed, and these actions depend on the subject's moderation. Therefore, it is necessary for the therapist to accurately set the intensity and number of times when teaching self-exercise as it is difficult to precisely reproduce the self-exercise without proper instructions and guidance.

Nonetheless, this study had several limitations. First, the asymptomatic adult male college students were in a narrow age range of 21.0 ± 0.8 years old, and future studies should investigate a population with a wider age range. Besides that, there could have been variations in the application and amount of force applied by the participant when performing self-SNAG. Furthermore, this study did not evaluate the alignment of the vertebral column because the subjects were asymptomatic. The vertebral column is involved in the balance of the hip bones in the sagittal plane and should be assessed as well to better evaluate the effectiveness of self-SNAG [36]. Finally, the sample size of this study was calculated using G*Power 3.1.9.2 before the start of the study, and the sample size was 30 (α = 0.05; 1–β = 0.8; effect size[25] = 1.0778376). However, it became difficult to recruit participants for this study due to the COVID-19 pandemic during the study period.

5. Conclusion

Although SNAG is thought to alleviate pain and improve movement, this study revealed that SNAG was not effective in the asymptomatic subjects of this study, as observed from the ROM and flexibility in the lower back and lower extremities. To interpret the results of this study (i.e., low intervention effect on asymptomatic individuals), the low effect size should also be considered. Based on our present findings, we aim to investigate the effects of self-SNAG on LBP and flexibility by implementing SNAG alone or a combined SNAG and self-SNAG intervention in patients with LBP in future studies.

Acknowledgments

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None.

Conflict of Interest

The authors declare no competing interests.

Ethics Approval and Consent to Participate

This study was conducted in accordance with the Declaration of Helsinki and was approved by the ethics committee at the Saitama Medical University (929). All participants agreed to sign an informed consent form.

Consent for Publication

All participants agreed to sign an informed consent form to use their data for this study.

Availability of Data

Not applicable.

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