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**Original Article**

# The Effectiveness of the Mulligan Concept Sustained Natural Apophyseal Glide Method in Patients with Non-specific Neck Pain: A Randomized Controlled Single-Blinded Trial

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### What is already known on this topic?

- *This study is one of the few studies investigating the long-term effectiveness of the sustained natural apophyseal glide (SNAG) method.*
- *The SNAG method was effective on the neck range of motion in individuals with non-specific neck pain (NSNP).*
- *The SNAG method was effective on pain in individuals with NSNP.*
- *The SNAG method was effective on the severity of neck disability in individuals with NSNP.*

## ABSTRACT

**Objective:** The study aimed to investigate the effectiveness of the Mulligan concept cervical sustained natural apophyseal glide (SNAG) mobilization method in people with non-specific neck pain (NSNP).

**Methods:** The study was conducted with 32 patients aged 18-50 years. The patients were divided randomly into the study (n = 16) and control (n = 16) groups. A total of 15 treatment sessions were applied to both groups. Joint range of motion (ROM) was evaluated with a universal goniometer, pain assessments with the short-form McGill questionnaire, functionality with the Neck Disability Index, quality of life with the Nottingham Health Profile scale, and sleep levels with the Pittsburgh Sleep Quality Index.

**Results:** Significant differences were detected in the measurement of ROM, pain, and neck disability severity before and after treatment in both the study and control groups ($P < .05$). Although no significant differences were detected in sleep quality and quality of life scores in the study group before and after treatment ($P > .05$), significant differences were detected in the control group ($P < .05$). After treatment, no differences were detected between the 2 groups in terms of ROM, pain, the severity of neck disability, sleep quality, and quality of life ($P > .05$).

**Conclusion:** The SNAG method was found to be effective in improving cervical ROM, reducing pain, and disability. This study highlights the clinical relevance of the SNAG method as a safe and effective manual therapy technique for improving cervical mobility and reducing pain in individuals with NSNP.

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**Keywords:** Manual therapy, neck pain, quality of life, range of motion, sleep quality

## Introduction

Neck pain is a musculoskeletal disorder that is quite common in the general population and frequently seen in Western societies.[1] Mechanical neck pain is a symptom-based disorder without cervical spinal pathologies (e.g., whiplash trauma, malignancy, or radiculopathy). The incidence of non-specific neck pain (NSNP) makes up approximately 25% of all outpatients in general clinics and 12-70% of the general population.[2] Because of its prevalence in the community, neck pain results in higher health costs in terms of loss of workforce, absenteeism, and treatment costs.[3]

Conservative and manual therapy (MT) approaches (e.g., exercise methods, massage, and acupuncture) are applied to control NSNP originating from the facet joint.[4,5] Manual therapy is increasingly used as a

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common treatment for patients with NSNP. Manual therapy includes both passive and active methods. The target of MT in NSNP is to reduce pain and improve movement, motor control, and function, thus reducing functional disabilities.[6]

The Mulligan Concept is one of the MT methods used for treatment in NSNP. It is reported in the literature that Mulligan concept sustained natural apophyseal glides (SNAGs) mobilizations from MT procedures are highly effective in the treatment of mechanical neck pain caused by disruption of joint mechanics.[7,8] The difference between this method and other mobilizations is that the patient's movement is also added to the procedure.[9] Sustained natural apophyseal glides are the procedure of mobilization force on the affected area (cervical, thoracic, and lumbar) of the patient performing a painful or limited movement.[10] As SNAGs correct a positional error in the facet joint, they reduce pain and increase the range of motion (ROM).[11]

Although there are studies conducted with the Mulligan concept in the literature, studies examining the effects of the SNAG method on NSNP are limited. In Fernández-Carnero's (2023) study, which examined the effect of the SNAG method applied also to conventional physiotherapy in people with neck pain, on pain and joint ROM, it was found that the SNAG method contributed positively to conventional physiotherapy in increasing the values of active joint ROM in the whole neck. Vijayan et al[12] (2022) used the SNAG method and conventional physiotherapy in patients with mechanical neck pain and showed that it had a positive effect on joint ROM and pain. However, Mulligan aims to fill the gap in the literature by examining the short-term effectiveness of the SNAG method on a ROM, severity of neck disability, pain, sleep quality, and quality of life in people with NSNP. The target of the current study was to investigate the effectiveness of the Mulligan Concept SNAGs mobilization method and the conventional physiotherapy program in people who had NSNP.



## Methods

### Individuals and Study Design

The study had a randomized controlled single-blind trial design.

Forty volunteer patients with non-specific mechanical neck pain who applied to İstinye University Gaziosmanpaşa Medikal Park Hospital were randomly divided into 2 groups by selecting one of 40 cards (20 labeled "1" and 20 labeled "2") from a closed box. The study group (card "1") received conventional physiotherapy and SNAG methods, while the control group (card "2") received only conventional physiotherapy. Both groups were provided with home exercise programs. A blinded researcher conducted the study assessments.

Patients aged 18-50 years with NSNP for at least 3 months, diagnosed by a specialist, and without radicular compression or loss of strength, were included. Exclusion criteria included central nervous system diseases, peripheral nerve injuries, inflammatory joint diseases, cervical spine conditions (such as fractures, surgeries, dislocations, tumors, infections, or congenital anomalies), upper extremity surgeries, vertebrobasilar artery stenosis, osteoporosis, and diabetes. Those taking medications that may affect sleep have been excluded from the study. Ethical approval for the study was obtained from the İstinye University Clinical Research Ethics Committee where it would be conducted (Approval No.: 2017-KAEK-120/2019-14), and informed consent was obtained from the participants.

### Sample Size

The Type 1 error was set at 0.05, and the Type 2 error at 0.80 for the study's targeted power. Based on Yılmaz's (2015) study on NSNP, the mean treatment difference (δ) was 4.37, and the SD difference (σ) was 1.42. Power analysis showed a minimum sample size of 28, with 14 individuals in each group. Considering possible data losses, 40 people were included in the study.

Of the 40 patients initially selected, 8 were excluded due to central nervous system disease (3), upper extremity fracture surgery (2), osteoporosis (2), and cervical congenital anomalies (1). The study proceeded with 32 eligible patients (Figure 1).

### Procedure

#### Conventional Physiotherapy

Patients underwent 15 treatment sessions (5 days/week for 3 weeks). The control and study group received conventional physiotherapy, including 10 minutes of intermittent ultrasound (1.5 w/cm²), 20

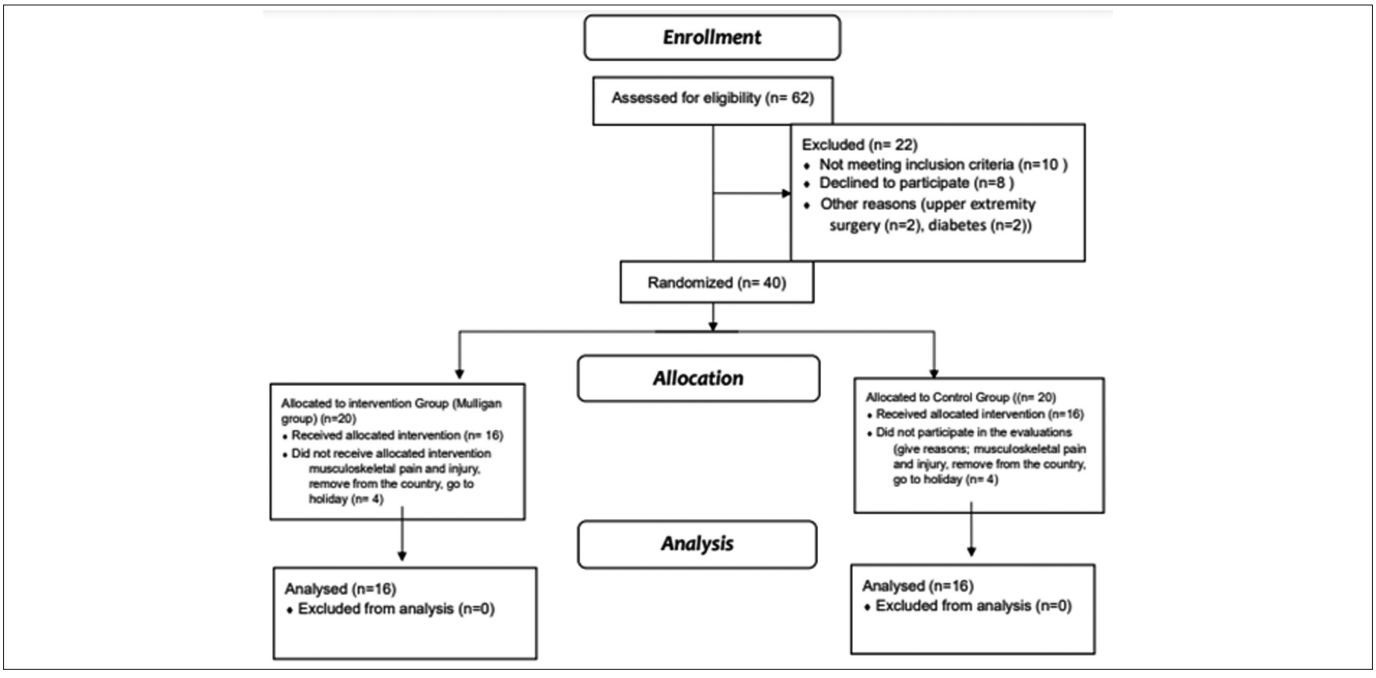


**Figure 1.** Flow chart of the study.

minutes of a hot pack, and 20 minutes of Transcutaneous Electrical Nerve Stimulation (TENS) (100Hz-30mA).

Home exercise programs with joint ROM and isometric neck muscle strengthening exercises were provided for use during the treatment period. Both groups were taught a home exercise program to enhance neck mobility and strength. Exercises included range-of-motion movements (flexion, extension, lateral flexion, rotation), brief hold at the endpoints, and isometric neck muscle strengthening.

**Mulligan Concept**

The SNAG method, conventional physiotherapy, and a home exercise program were applied to the study group. For the SNAG method, the patient was asked to take a sitting position. Then, the thumbs of the hand were placed on all the cervical facet joints of the patient in turn, and the patient was shifted with continuous passive accessory intervertebral motion in the superior anterior direction, and the patient was asked to rotate to the related facet joint direction at the same time. At the end of this position, the patient was asked to hold this position for a few seconds (Figure 2). Mobilization was performed in 3 sets with 5 repetitions at each spinal level, with the patient resting for 5 seconds between sets.[11]

**Evaluation Parameters**

Sociodemographic data (age, gender, alcohol-smoking status) were collected from all participants. The cervical joint ROM was measured with a universal goniometer. The Neck Disability Index (NDI) assessed movement-related disability, pain was evaluated using the short-form McGill Pain Questionnaire, quality of life with the Nottingham Health Profile, and sleep quality with the Pittsburgh Sleep Quality Index (PSQI).

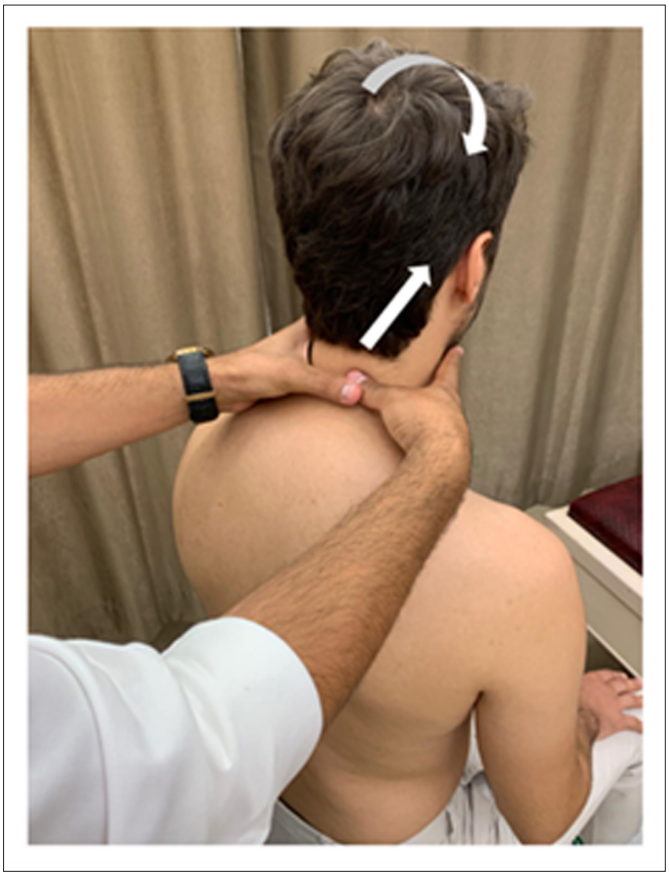

**Figure 2.** Positioning of hands and fingers in the sustained natural apophyseal glide method.

**Sociodemographic Characteristics**

To determine the personal data, a sociodemographic form that included descriptive information (e.g., gender, age, marital status, living environment, education level, income level, working status, social security, alcohol use, and smoking status) was used.

**Joint Range of Motion**

The ROM of the cervical vertebrae was measured and recorded with a universal goniometer before and after the treatment.[13] The active-passive flexion-extension, right-left rotation, and right-left lateral flexion in the cervical region were measured when the patient was in a sitting position.[14]

**Neck Disability Severity**

The NDI is sensitive to change in a population of patients suffering from neck pain (10 questions in total). The total score ranged from 0 to 50. A low total score on the scale indicates that the neck movements are close to normal, and a high one indicates a high limitation of movement in the neck.[15] Its validity and reliability in Turkish have been established by Aslan et al.[16]

**Pain**

The Short Form McGill Pain Questionnaire (SF-MPQ), which provides information about the effect, sensory characteristics, and severity of pain, was used for pain assessment. The questionnaire was found valid and reliable by Melzack in 1987 to measure pain and consists of a total of 15 descriptive words to determine the sensory (11 words) and affective (4 words) dimensions of pain. The pain intensity (0 = absent, 1 = mild, 2 = moderate, 3 = severe) is evaluated, and 3 pain scores (sensory, affective, and total pain ratio = sensory + affective) are obtained in this section.[17] The validity and reliability of the SF-MPQ were established by Aykan et al.[18]

**Sleep Quality**

Sleep quality was evaluated with the PSQI, which is the valid and reliable most commonly used generic measure in clinical and research settings. It is a self-report questionnaire used by clinicians and researchers to broadly assess various aspects of sleep. The PSQI consists of 24 questions, and the total score is between 0 and 21. The lower the score, the better the individual's sleep quality.[19] The PSQI has been validated and verified for reliability in Turkish.[20]

**Quality of Life**

The Nottingham Health Profile is a test with proven validity and reliability. [21] The total score on this scale ranges from 0 to 66. A high score on the scale, according to the measurement result, indicates that the quality of life of the person is good.[22]

**Analysis of Data**

Statistical analysis was performed using SPSS 20. The Kolmogorov–Smirnov Test assessed data normality. Parametric methods analyzed normally distributed data, while non-parametric methods analyzed non-normal data. Changes were reported as mean ± SD (X ± SD), and percentages (%) were used for count-based values. The Wilcoxon Signed Rank Test compared pre- and post-treatment scores, and the Mann–Whitney *U*-test compared intergroup continuous variables. The Greenhouse–Geisser correction was applied when sphericity was violated. Statistical significance was set at a 5% Type 1 error level.

**Results**

The descriptive statistics for the personal characteristics of the individuals in the study group and control group are given in Table 1.

**Table 1.** Sociodemographic and Clinical Data of Individuals in the Study Group and Control Group (n = 32)

| | | Study (Mulligan) Group, n (%) | Control Group, n (%) |
|---|---|---|---|
| Gender | Female | 12 (75.0) | 11 (68.8) |
| | Male | 4 (25.0) | 5 (31.3) |
| Age | 18-30 | 11 (68.8) | 6 (37.5) |
| | 31-40 | 4 (25.0) | 6 (37.5) |
| | 41-50 | 1 (6.2) | 4 (25) |
| Living environment | Alone | 6 (37.5) | 3 (18.8) |
| | With wife and children | 6 (37.5) | 9 (56.3) |
| | With parents | 4 (25.0) | 4 (25) |
| Education status | Primary education | 1 (6.2) | 4 (25) |
| | High school | 3 (18.8) | 6 (37.5) |
| | University | 12 (75.0) | 6 (37.5) |
| Employment status | Not working | 5 (31.2) | 3 (18.8) |
| | Desk-based work | 9 (56.3) | 6 (37.5) |
| | Physical labor | 2 (12.5) | 7 (43.8) |
| Social security | Private insurance | 2 (12.5) | 1 (6.3) |
| | Social Security Institution (SSI) | 14 (87.5) | 10 (62.5) |
| | None | 0 (0.0) | 5 (31.3) |
| Alcohol use status | Yes | 3 (18.8) | 5 (31.3) |
| | No | 13 (81.2) | 11 (68.8) |
| Smoking status | Yes | 6 (37.5) | 12 (75) |
| | No | 10 (62.5) | 4 (25) |

%, percentage; n, number of individuals.

### Range of Motion

Statistically significant differences were detected in the neck active ROM measurements of the individuals in the study and control groups before and after the procedure ($P < .05$) (Table 2).

According to the findings, significant differences were detected between the active left rotation values of the individuals in the study group and the control group before the procedure ($P < .05$). After the procedure period, no significant difference was found between the 2 groups ($P > .05$). According to the findings, there were significant differences between the active flexion and active left rotation values of the individuals in the study group and the control group ($P < .05$) (Table 3).

The difference between passive flexion, passive left rotation, passive right rotation, and passive right lateral flexion values of the individuals in the study group was found to be statistically significant ($P < .05$). Significant differences were detected in the control group between the values of passive flexion, passive extension, passive left rotation, and passive right rotation ($P < .05$) (Table 2).

According to the findings, significant differences were detected between the passive right lateral flexion values of the individuals in the study group and the control group before the physiotherapy procedure ($P < .05$). No differences were detected in any parameter between the 2 groups after the procedure (Table 3).

### Pain

The differences among the NDI ($P < .05$), perceptual pain score ($P < .05$), and pain ($P < .01$) values measured before and after the procedure period of the individuals in the study group were found to be statistically significant. The difference between NDI ($P < .01$), total pain score ($P < .05$), sensory pain score ($P < .01$), pain intensity ($P < .05$), and pain ($P < .01$) values was statistically significant in the control group (Table 2).

No significant differences were detected between the pre- and post-procedure values regarding the pain level of the individuals in the study group participating in the study and the control group ($P > .05$) (Table 3).

**Table 2.** Evaluation of the Change Between the Pretest and Post-Test Results of the Individuals in the Study Group and the Control Group Regarding the Neck Active Normal Joint Motion Measurements, Neck Passive Normal Joint Motion Measurements, Pain Level Scale Scores: Primary Outcomes

| | Intervention (Mulligan) Group | | | | | Control Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pretest | Post-Test | | | Effect | Pretest | Post-Test | | | Effect |
| | $\bar{X} \pm SS$ | $\bar{X} \pm SS$ | *Z* | *P* | Size | $\bar{X} \pm SS$ | $\bar{X} \pm SS$ | *Z* | *P* | Size |
| **Neck Active Range of Motion** | | | | | | | | | | |
| Degree of flexion (°) | 42.63 ± 5.73 | 47.75 ± 3.34 | −3.01 | **.003**** | 1.09 | 45.88 ± 5.93 | 47.81 ± 4.21 | −2.08 | **.038*** | 0.37 |
| Degree of extension (°) | 49.88 ± 7.17 | 54.88 ± 6.08 | −2.61 | **.019**** | 0.75 | 53.69 ± 7.28 | 56.75 ± 5.00 | −2.38 | **.017*** | 0.48 |
| Left rotation degree (°) | 65.31 ± 7.49 | 73.88 ± 5.25 | −3.49 | **.001**** | 1.32 | 72.50 ± 6.15 | 76.88 ± 4.43 | −3.21 | **.001**** | 0.81 |
| Degree of right rotation (°) | 66.06 ± 9.47 | 75.25 ± 4.81 | −3.22 | **.001**** | 1.22 | 72.00 ± 7.56 | 76.88 ± 4.43 | −2.75 | **.006**** | 0.78 |
| Left lateral flexion degree (°) | 40.75 ± 4.43 | 43.94 ± 2.32 | −2.58 | **.010*** | 0.90 | 40.56 ± 5.56 | 43.75 ± 2.89 | −2.41 | **.016*** | 0.71 |
| Right lateral flexion degree (°) | 37.19 ± 6.78 | 43.25 ± 2.21 | −2.96 | **.003**** | 1.20 | 41.50 ± 4.84 | 44.38 ± 1.71 | −2.41 | **.016*** | 0.79 |
| **Neck Passive Range of Motion** | | | | | | | | | | |
| Flexion degree (°) | 46.25 ± 5.00 | 49.56 ± 1.31 | −2.20 | **.028*** | 0.90 | 47.88 ± 3.70 | 49.38 ± 1.71 | −2.06 | **.039*** | 0.52 |
| Degree of flexion (°) | 53.31 ± 7.23 | 57.69 ± 5.12 | −1.89 | .058 | 0.69 | 56.88 ± 4.70 | 58.44 ± 3.01 | −2.06 | **.039*** | 0.39 |
| Degree of extension (°) | 70.50 ± 9.76 | 79.25 ± 1.73 | −2.96 | **.003**** | 1.24 | 76.44 ± 3.61 | 78.75 ± 2.24 | −2.46 | **.014*** | 0.76 |
| Left rotation degree (°) | 71.50 ± 10.60 | 79.38 ± 1.71 | −2.51 | **.012*** | 1.03 | 75.38 ± 5.68 | 78.44 ± 2.39 | −2.15 | **.031*** | 0.70 |
| Degree of right rotation (°) | 42.63 ± 3.58 | 44.69 ± 1.25 | −1.87 | .062 | 0.76 | 43.63 ± 2.22 | 44.69 ± 1.25 | −1.44 | .149 | 0.58 |
| Left lateral flexion degree (°) | 41.00 ± 4.35 | 44.69 ± 1.25 | −2.75 | **.006**** | 1.15 | 43.63 ± 2.33 | 44.69 ± 1.25 | −1.38 | .168 | 0.58 |
| **Scale Scores for Pain Level** | | | | | | | | | | |
| Total Pain Score (SF-MPQ) | 7.63 ± 5.73 | 7.38 ± 7.10 | −0.34 | .733 | 0.03 | 13.19 ± 10.47 | 8.13 ± 8.75 | −2.59 | **.010*** | 0.52 |
| Sensory Pain Score (SF-MPQ) | 4.63 ± 4.00 | 6.13 ± 5.61 | −0.85 | .396 | 0.30 | 9.25 ± 8.01 | 6.06 ± 6.88 | −2.70 | **.007**** | 0.42 |
| Perceptual Pain Score (SF-MPQ) | 3.00 ± 2.90 | 1.25 ± 2.57 | −2.02 | **.044*** | 0.63 | 3.94 ± 3.43 | 2.06 ± 2.43 | −1.91 | .056 | 0.63 |
| Pain Severity (SF-MPQ) | 1.69 ± 0.87 | 1.31 ± 0.70 | −1.73 | .083 | 0.48 | 1.88 ± 0.81 | 1.31 ± 1.25 | −2.18 | **.029*** | 0.54 |
| Pain (Visual Analog Scale (VAS)) | 4.75 ± 2.08 | 2.44 ± 1.67 | −3.46 | **.001**** | 0.22 | 5.06 ± 2.64 | 2.44 ± 2.25 | −3.54 | **.001**** | 1.06 |

$\bar{X} \pm SS$, Mean ± SD; *Z*, Wilcoxon Signed Rank Test.
*$P < .05$.
**$P < .01$.

**Table 3.** Comparison of the Difference Between the Pretest and Post-Test Results of the Individuals in the Study Group and the Control Group Regarding Neck Active Normal Joint Motion Measurements, Neck Passive Normal Joint Motion Measurements, Pain Level Scale Scores: Primary Outcomes

| | Pretest | | | | | Post-Test | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Intervention (Mulligan) Group | Control Group | | | Effect Size | Intervention (Mulligan) Group | Control Group | | | Effect Size |
| | $\bar{X} \pm SS$ | $\bar{X} \pm SS$ | *U* | *P* | | $\bar{X} \pm SS$ | $\bar{X} \pm SS$ | *U* | *P* | |
| **Neck Active Range of Motion** | | | | | | | | | | |
| Degree of flexion (°) | 42.63 ± 5.73 | 45.88 ± 5.93 | 80.5 | .062 | 0.56 | 47.75 ± 3.34 | 47.81 ± 4.21 | 120.5 | .738 | 0.02 |
| Degree of extension (°) | 49.88 ± 7.17 | 53.69 ± 7.28 | 86.0 | .107 | 0.53 | 54.88 ± 6.08 | 56.75 ± 5.00 | 103.5 | .313 | 0.34 |
| Left rotation degree (°) | 65.31 ± 7.49 | 72.50 ± 6.15 | 60.5 | **.010*** | 1.04 | 73.88 ± 5.25 | 76.88 ± 4.43 | 81.0 | .060 | 0.62 |
| Degree of right rotation (°) | 66.06 ± 9.47 | 72.00 ± 7.56 | 80.5 | .071 | 0.69 | 75.25 ± 4.81 | 76.88 ± 4.43 | 103.0 | .309 | 0.35 |
| Left lateral flexion degree (°) | 40.75 ± 4.43 | 40.56 ± 5.56 | 127.5 | .984 | 0.04 | 43.95 ± 2.32 | 43.75 ± 2.89 | 127.5 | .978 | 0.08 |
| Right lateral flexion degree (°) | 37.19 ± 6.78 | 41.50 ± 4.84 | 80.0 | .058 | 0.73 | 43.25 ± 2.21 | 44.38 ± 1.71 | 91.0 | .077 | 0.73 |
| **Neck Passive Range of Motion** | | | | | | | | | | |
| Degree of flexion (°) | 46.25 ± 5.00 | 47.88 ± 3.70 | 108.0 | .384 | 0.37 | 49.56 ± 1.31 | 49.38 ± 1.71 | 127.0 | .948 | 0.12 |
| Degree of extension (°) | 53.31 ± 7.23 | 56.88 ± 4.70 | 92.0 | .140 | 0.59 | 57.69 ± 5.12 | 58.44 ± 3.01 | 126.5 | .941 | 0.18 |
| Left rotation degree (°) | 70.50 ± 9.76 | 76.44 ± 3.61 | 79.5 | .057 | 0.81 | 79.25 ± 1.73 | 78.75 ± 2.24 | 118.0 | .600 | 0.25 |
| Degree of right rotation (°) | 71.50 ± 10.60 | 75.38 ± 5.68 | 111.5 | .515 | 0.46 | 79.38 ± 1.71 | 78.44 ± 2.39 | 104.0 | .207 | 0.45 |
| Left lateral flexion degree (°) | 42.63 ± 3.58 | 43.63 ± 2.22 | 111.0 | .457 | 0.34 | 44.69 ± 1.25 | 44.69 ± 1.25 | 128.0 | 1.000 | 0.00 |
| Right lateral flexion degree (°) | 41.00 ± 4.35 | 43.63 ± 2.33 | 80.5 | **.049*** | 0.75 | 44.69 ± 1.25 | 44.69 ± 1.25 | 128.0 | 1.000 | 0.00 |
| **Scale Scores for Pain Level** | | | | | | | | | | |
| Total Pain Score (TPS-CF) | 7.63 ± 5.73 | 13.19 ± 10.47 | 92.5 | .180 | 0.66 | 0.34 ± 0.28 | 0.34 ± 0.36 | 118.0 | .705 | 0.10 |
| Sensory Pain Score (MAQ-CF) | 4.63 ± 4.00 | 9.25 ± 8.01 | 86.0 | .112 | 0.73 | 7.38 ± 7.10 | 8.13 ± 8.75 | 126.5 | .954 | 0.01 |
| Perceptual Pain Score (MAQ-CF) | 3.00 ± 2.90 | 3.94 ± 3.43 | 110.5 | .505 | 0.30 | 6.13 ± 5.61 | 6.06 ± 6.88 | 119.5 | .743 | 0.32 |
| Pain Severity (MAQ-CF) | 1.69 ± 0.87 | 1.88 ± 0.81 | 114.0 | .575 | 0.23 | 1.25 ± 2.57 | 2.06 ± 2.43 | 97.0 | .204 | 0.00 |
| Pain (VAS) | 4.75 ± 2.08 | 5.06 ± 2.64 | 114.0 | .593 | 0.13 | 1.31 ± 0.70 | 1.31 ± 1.25 | 122.0 | .813 | 0.00 |

$\bar{X} \pm SS$, Mean ± SD; *U*, Mann–Whitney *U*-test.
*$P < .05$.
**$P < .01$.

### Sleep Quality

When the sleep quality of individuals was examined, no significant differences were detected before and after the procedure in the study group ($P > .05$), while in the control group, the sleep quality score ($P < .01$), sleep latency score ($P < .05$), sleep duration score ($P < .05$), The differences between sleep disorder score ($P < .01$), sleep medication use score ($P < .05$) and daytime dysfunction scores ($P < .05$) were statistically significant (Table 4).

**Table 4.** Evaluation of the Change Between the Pretest and Post-Test Results of the Scale Scores for Activities of Daily Living, Scale Scores for Mood, and Scale Scores for Sleep Quality of the Individuals in the Study Group and the Control Group: Secondary Outcomes

| | Intervention (Mulligan) Group | | | | | Control Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pretest | Post-Test | | | Effect Size | Pretest | Post-Test | | | Effect Size |
| | $\bar{X} \pm SS$ | $\bar{X} \pm SS$ | *Z* | *P* | | $\bar{X} \pm SS$ | $\bar{X} \pm SS$ | *Z* | *P* | |
| **Neck Disability Level** | | | | | | | | | | |
| Neck Disability Index (NDI) | 0.54 ± 0.26 | 0.34 ± 0.28 | −2.28 | **.023*** | 0.74 | 0.60 ± 0.22 | 0.34 ± 0.36 | −2.62 | **.009**** | 0.87 |
| **Pittsburgh Sleep Quality Index (PSQI)** | | | | | | | | | | |
| Sleep quality | 6.44 ± 2.42 | 5.81 ± 2.93 | −1.16 | .245 | 0.23 | 9.13 ± 4.66 | 6.13 ± 3.26 | −3.43 | **.001**** | 0.74 |
| Individual sleep quality | 1.31 ± 0.60 | 1.38 ± 0.96 | −.30 | .763 | 0.08 | 1.44 ± 0.81 | 1.13 ± 0.62 | −1.89 | .059 | 0.42 |
| Sleep latency | 1.50 ± 0.89 | 1.13 ± 0.89 | −1.39 | .166 | 0.41 | 1.63 ± 1.09 | 1.13 ± 0.96 | −2.53 | **.011*** | 0.48 |
| Sleep duration | 0.81 ± 1.11 | 0.69 ± 1.08 | −0.42 | .672 | 0.10 | 1.44 ± 1.15 | 0.81 ± 0.83 | −2.46 | **.014*** | 0.62 |
| Habitual sleep efficiency | 0.38 ± 0.81 | 0.25 ± 0.77 | −0.56 | .577 | 0.16 | 0.38 ± 0.81 | 0.44 ± 0.51 | −0.33 | .739 | 0.08 |
| Sleep disturbance | 1.25 ± 0.58 | 1.38 ± 0.89 | −.50 | .617 | 0.17 | 1.88 ± 0.72 | 1.19 ± 0.75 | −3.32 | **.001**** | 0.93 |
| Use of sleeping medication | 0.19 ± 0.54 | 0.19 ± 0.40 | .00 | 1.000 | 0.02 | 0.81 ± 1.22 | 0.50 ± 0.97 | −2.24 | **.025*** | 0.28 |
| Daytime dysfunction | 1.00 ± 0.73 | 0.81 ± 0.75 | −0.78 | .439 | 0.25 | 1.56 ± 0.89 | 0.94 ± 0.77 | −2.14 | **.032*** | 0.74 |
| **Scale Scores for Nottingham Activities of Daily Living (NADL)** | | | | | | | | | | |
| Total score | 58.50 ± 6.27 | 60.50 ± 4.37 | −0.91 | .363 | 0.37 | 56.31 ± 7.25 | 60.50 ± 4.99 | −1.76 | .078 | 0.67 |
| Mobility | 17.88 ± 0.50 | 17.25 ± 1.53 | −1.47 | .143 | 0.55 | 17.56 ± 1.09 | 17.31 ± 1.14 | −0.86 | .391 | 0.22 |
| In the kitchen | 12.75 ± 3.21 | 14.56 ± 0.81 | −1.93 | .054 | 0.77 | 13.06 ± 2.89 | 14.38 ± 1.09 | −1.35 | .178 | 0.60 |
| Domestic tasks | 13.44 ± 3.22 | 13.94 ± 1.98 | −0.29 | .765 | 0.18 | 12.00 ± 3.41 | 13.88 ± 2.00 | −2.11 | **.035*** | 0.67 |
| Leisure activities | 14.44 ± 3.81 | 14.75 ± 4.16 | −0.63 | .528 | 0.07 | 13.69 ± 4.06 | 14.94 ± 4.01 | −1.05 | .294 | 0.30 |

$\bar{X} \pm SS$, Mean ± SD; *Z*, Wilcoxon Signed Rank Test.
*$P < .05$.
**$P < .01$.

**Table 5.** Comparison of the Difference Between the Pretest and Post-Test Results of the Scale Scores for Activities of Daily Living, Scale Scores for Mood, and Scale Scores for Sleep Quality of the Individuals in the Study Group and the Control Group: Secondary Outcomes

| | Pretest | | | | | Post-Test | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Intervention (Mulligan) Group | Control Group | | | Effect Size | Intervention (Mulligan) Group | Control Group | | | Effect Size |
| | $\bar{X} \pm SS$ | $\bar{X} \pm SS$ | *U* | *P* | | $\bar{X} \pm SS$ | $\bar{X} \pm SS$ | *U* | *P* | |
| **Neck Disability Level** | | | | | | | | | | |
| Neck Disability Index (NDI) | 0.54 ± 0.26 | 0.60 ± 0.22 | 119.5 | .747 | 0.25 | 0.34 ± 0.28 | 0.34 ± 0.36 | 118.0 | .705 | 0.00 |
| **Pittsburgh Sleep Quality Index (PSQI)** | | | | | | | | | | |
| Sleep quality | 6.43 ± 2.42 | 9.12 ± 4.6 | 79.0 | .062 | 0.73 | 5.81 ± 2.93 | 6.13 ± 3.26 | 118.0 | .704 | 0.10 |
| Individual sleep quality | 1.31 ± 0.60 | 1.44 ± 0.81 | 122.0 | .799 | 0.18 | 1.38 ± 0.96 | 1.13 ± 0.62 | 109.0 | .437 | 0.31 |
| Sleep latency | 1.50 ± 0.89 | 1.63 ± 1.09 | 118.0 | .694 | 0.13 | 1.13 ± 0.89 | 1.13 ± 0.96 | 128.0 | 1.000 | 0.00 |
| Sleep duration | 0.81 ± 1.11 | 1.44 ± 1.15 | 86.5 | .098 | 0.56 | 0.69 ± 1.08 | 0.81 ± 0.83 | 109.5 | .444 | 0.12 |
| Habitual sleep efficiency | 0.38 ± 0.81 | 0.38 ± 0.81 | 128.0 | 1.000 | 0.00 | 0.25 ± 0.77 | 0.44 ± 0.51 | 91.5 | .079 | 0.29 |
| Sleep disturbance | 1.25 ± 0.58 | 1.88 ± 0.72 | 70.0 | **.016*** | 0.96 | 1.38 ± 0.89 | 1.19 ± 0.75 | 112.0 | .519 | 0.23 |
| Use of sleeping medication | 0.19 ± 0.54 | 0.81 ± 1.22 | 93.5 | .087 | 0.66 | 0.19 ± 0.40 | 0.50 ± 0.97 | 115.5 | .514 | 0.42 |
| Daytime dysfunction | 1.00 ± 0.73 | 1.56 ± 0.89 | 82.0 | .066 | 0.69 | 0.81 ± 0.75 | 0.94 ± 0.77 | 118.5 | .692 | 0.17 |
| **Scale Scores for Nottingham Activities of Daily Living (NADL)** | | | | | | | | | | |
| Total score | 58.50 ± 6.27 | 56.31 ± 7.25 | 107.0 | .428 | 0.32 | 60.50 ± 4.37 | 60.50 ± 4.99 | 122.5 | .835 | 0.00 |
| Mobility | 17.88 ± 0.50 | 17.56 ± 1.09 | 112.0 | .294 | 0.38 | 17.25 ± 1.53 | 17.31 ± 1.14 | 126.0 | .929 | 0.04 |
| In the kitchen | 12.75 ± 3.21 | 13.06 ± 2.89 | 127.5 | .984 | 0.10 | 14.56 ± 0.81 | 14.38 ± 1.09 | 123.5 | .835 | 0.19 |
| Domestic tasks | 13.44 ± 3.22 | 12.00 ± 3.41 | 85.0 | .074 | 0.43 | 13.94 ± 1.98 | 13.88 ± 2.00 | 125.5 | .916 | 0.03 |
| Leisure activities | 14.44 ± 3.81 | 13.69 ± 4.06 | 112.0 | .537 | 0.19 | 14.75 ± 4.16 | 14.94 ± 4.01 | 125.0 | .906 | 0.05 |

$\bar{X} \pm SS$, Mean ± SD; *U*, Mann–Whitney *U*-test.
**P* < .05.
***P* < .01.



No statistically significant differences were detected between the measurements made before and after the procedure period of the individuals in the study and control groups (*P* > .05) (Table 5).

### Quality of Life

No statistically significant differences were detected between the values of any parameter in terms of the Nottingham Health Profile index score results of the individuals in the study group before and after the procedure (*P* > .05). Statistically significant differences were found only between housework score values in the control group (*P* < .05) (Table 4).

No significant differences were detected between the quality-of-life parameters of the individuals participating in the study and the control group before and after the procedure (*P* > .05) (Table 5).

## Discussion

The present study that investigated the short-term effectiveness of the Mulligan SNAG method on people who had NSNP found that the SNAG method was effective on neck joint ROM, pain, and severity of neck disability. When the literature was reviewed to the best of the authors' knowledge, this study is one of the few studies investigating the effectiveness of the SNAG method. A total of 32 patients with NSNP participated in this study, and the results revealed a similar finding in neck joint ROM, pain level, severity of disability, sleep quality, and quality of life between conventional therapy and conventional therapy & Mulligan SNAG method.

It is already known that people who have neck pain have a lower neck active ROM than people who have neck pain.[11,23] In the study of Fernández-Carnero et al[11] (2022), who examined the effects of the SNAG method applied also to conventional physiotherapy in people with neck pain, on pain and joint ROM, it was found that the SNAG method contributed positively to conventional physiotherapy in increasing the values of active joint ROM in the whole neck. Vijayan et al[12] (2022) also used the SNAG method in conventional physiotherapy in patients with mechanical neck pain and showed that it had a positive effect on joint ROM and pain. In their study on the effectiveness of the SNAG method in older adults with neck pain, Büyükturan et al[8] (2018) found that the SNAG method did not contribute to conventional physiotherapy in increasing the active ROM of the neck. Again, it was determined by Mohamed and Shendy[19] (2018) that the Mulligan method did not contribute to conventional physiotherapy on joint ROM, pain, and neck disability levels in patients with cervicogenic headaches. The data obtained in the present study were consistent with the literature data, and it was determined that the SNAG method did not affect neck joint ROM in people who had NSNP compared to the control group. When the pre- and post-procedure values of the individuals who underwent the SNAG method were analyzed, the improvement in all movements was higher in the study group compared to the control group. This is because the SNAG method regulates the repositioning of the facet joint by providing biomechanical restoration of the joint space.[8,24] The high effect sizes of active and passive ROM are one of the superior aspects of this study.

In people who have pain in the neck region, the increased pain levels cause disability and may affect the quality of life negatively.[25] In a study conducted by Akhter et al[21] (2014) with patients with non-specific chronic neck pain, it was found that the Maitland MT method contributed to conventional physiotherapy in reducing the level of pain. In the study conducted by Said et al[22] (2017) with people who had chronic mechanical neck pain, it was determined that the SNAG method contributed to conventional physiotherapy in reducing the level of pain. The study by Fernández-Carnero et al[11] (2022) that was conducted with patients with neck pain found that the SNAG method had a positive effect on conventional physiotherapy in reducing pain levels measured at rest and during activity. Vijayan et al[12] (2022) found that the SNAG method was effective in reducing pain levels in patients with mechanical neck pain. In a study conducted by Copurgensli et al[23]

(2017) with patients with cervical spondylosis, it was reported that the SNAG method did not provide an additional contribution to conventional physiotherapy in reducing pain levels measured at rest and during activity. As seen in the literature data, the effectiveness of the SNAG method on pain is still controversial. The transmission of pain to the central nervous system is reduced by providing proprioceptive input with the SNAG method, and thermal and pressure input in conventional physiotherapy.[26,27] For this reason, the hypoalgesic effect is observed in both groups. For this reason, in this study, it was observed that the level of pain decreased in both groups and there was no difference between the groups.

In their study, Alansari et al[24] (2021) reported a decrease in NDI values in patients with NSNP in which they compared SNAGs and Maitland methods. However, when the groups were compared, the 2 methods were found to have similar effects. Ali et al[25] (2014) conducted a study in which patients with NSNP applied SNAGs and an isometric exercise program, and only SNAGs showed improvement in NDI values. In this study, NDI improvement was observed in both groups, which is consistent with the literature data. However, when the groups were compared, no differences were detected between the groups. The SNAG method was found to be effective with the neurophysiological production mechanism and biomechanical restoration of the joint based on stimulation of peripheral mechanoreceptors and inhibition of nociceptors and altering the sympathetic nervous system. This treatment method modulates pain by activating the pain reliever system in the central nervous system, which provides instant relief from the pain sensation of the person. It is also observed that the effect size of NDI is high in this study.

It is seen that the pain reaches a level that affects the sleep quality of individuals with neck pain caused by various reasons.[28] In the study of Muñoz-Muñoz et al[27] (2012) , which examined the relationship between myofascial trigger points with neck pain and sleep quality, it was determined that the sleep quality of people who had mechanical neck pain was lower than the healthy group. In a study conducted by Castro-Sanchez et al[29] (2014) with people who had fibromyalgia syndrome, it was determined that MT practice was effective in improving the sleep quality of individuals. As a result of the study of Yıldırım Güzelant et al[30] (2014) on the effect of physical treatment on disability severity, sleep, and psychological state in the short term in patients with chronic neck pain, it was determined that conventional physiotherapy contributed to increasing the sleep quality level of individuals. Unlike the studies in the literature, when the short-term results were compared between the SNAG method and the control group, sleep quality levels were similar in the results of this study. No change was observed in the sleep quality level of the group to which SNAGs were applied in the group evaluations. However, to the best of the authors' knowledge, no study examining sleep quality in people who had NSNP has been found.

Neck pain affects the quality of life of individuals negatively.[31] There are studies in the literature examining the effect of MT on the quality of life in patients with neck pain. Celenay et al[32] (2014) found that cervical and scapular mobilization together with stabilization exercises were effective in the quality of life of patients with chronic neck pain. As a result of the study that was conducted by Fernández-Carnero et al[11] (2022), it was reported that the Mulligan method contributed to increasing the quality of life. However, unlike these results, the study of Dziedzic et al[33] (2005) showed that MT did not affect the quality of life. Evans et al[34] (2012) found that MT does not contribute to improving the quality of life in patients with neck pain. As a result, there are different opinions on this subject in the literature. In this study, it was determined that the SNAG method did not provide an additional contribution to conventional physiotherapy in increasing the quality of life in people who had NSNP. It is thought that this is because of the evaluation of the short-term results of the intervention.

The present study is among the few studies in the literature evaluating the effectiveness of the SNAG method in people who had NSNP. One of the important results of the study was that the SNAG method, a MT method, can be used safely in adults with NSNP without harming individuals. Also, an increase in painless ROM and a decrease in the severity of neck disability were obtained by reducing functional limitations in adults with NSNP. Although this study is one of the few studies in the literature evaluating the effectiveness of the SNAG method in people who had NSNP, there are no studies investigating the effectiveness of this method also for other parameters in sleep quality in adults with NSNP. The 2 strengths of this study are that the patient group consisted of adults with NSNP and that it was a randomized controlled single-blind study.

### Limitations

One of the limitations of the study was that the long-term results of the SNAG method were not evaluated. It is considered that it should be questioned in future studies because pain duration changes the interpretation of pain in the central nervous system.

### Conclusion

The current study examined the SNAG method's short-term effectiveness on individuals with NSNP and found that it improved the neck's ROM, discomfort, and the severity of neck disability. It has been shown that the SNAG method can be used in addition to conventional treatment in cases where early positive results on a ROM, pain level, the severity of the disability, sleep quality, and quality of life are desired in NSNP.



**Data Availability Statement:** The data that support the findings of this study are available on request from the corresponding author.

**Ethics Committee Approval:** Ethical committee approval was received from the İstinye University Clinical Research Ethics Committee (Approval No.: 2017-KAEK-120/2019-14).

**Informed Consent:** Written informed consent was obtained from patients at İstinye University Gaziosmanpaşa Medikal Park Hospital who participated in this study.

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