International Journal of Decision Support System Technology
Volume 16 • Issue 1 • January-December 2024

Variable Resistance Training Combined With Static Traction Computer Vision Applied in Neck and Shoulder Rehabilitation Training for College Students

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ABSTRACT

This study evaluates the effectiveness of static traction combined with variable resistance training in rehabilitating college students with neck and shoulder diseases. Ninety students were randomly assigned to receive either static traction alone or combined therapy. Visual analogue scale (VAS), neck disability index (NDI), cervical range of motion, electromyography (EMG), and soft tissue parameters were assessed pre- and post-treatment. Both groups showed improved VAS and NDI scores post-treatment, with greater enhancements in the combined therapy group. Cervical range of motion, EMG values, and soft tissue parameters also favored the combined therapy. Statistical analysis revealed significant differences (P<0.05) between groups. Static traction combined with variable resistance training effectively improves neck and shoulder function, reduces pain, and enhances rehabilitation outcomes compared to static traction alone. This approach shows promise for optimizing rehabilitation in college students with similar musculoskeletal conditions.

KEYWORDS

College Students, Computer Vision, Computer-Aided Analysis, Neck and Shoulder Rehabilitation Training, Static Traction, Variable Resistance Training

INTRODUCTION

Neck and shoulder disorders are a common cause of chronic pain among young people and are mainly caused by continuous and improper sitting postures (Pacheco et al., 2023). Cervical spondylosis and periarthritis humeroscapularis are the most common neck and shoulder conditions, which are characterized by long treatment courses and intractability. The above two symptoms

DOI: 10.4018/IJDSST.358616

have been a long-standing source of pain for patients. Meanwhile, in recent years, there has been a growing trend toward an increased focus on health (Warda et al., 2023). Early intervention and treatment of neck and shoulder disorders can improve the condition of patients and prevent aggravation (Montpetit-Tourangeau et al., 2023). Patients with both cervical spondylosis and periarthritis humeroscapularis may experience painful symptoms that can cause physical and mental suffering, which can disrupt their daily lives and sleep schedules. Various neck and shoulder conditions can also result in other complications, such as hand numbness, fatigue, and dizziness, which can add to the discomfort that these patients experience (Jeong & Lee, 2024). In addition, recurrent neck and shoulder disorders can cause depression, anxiety, and dysphoria in patients, so that they can hardly eat and sleep normally, which can seriously impact their quality of life (Kärkkäinen et al., 2023).

Treatment options for various neck and shoulder disorders include both medication-based and non-drug therapies (Metalnikov et al., 2024). In terms of medication-based therapy (Farishta et al., 2024), analgesics are administered for relieving pain, a treatment characterized by its fast-acting effectiveness for relieving pain and simple administration. While effective, it is not ideal because it does not cure the underlying condition, and patients still suffer from long-term, recurring symptoms, which can negatively impact their lives (Vivarelli et al., 2023). Non-drug treatments include surgery and rehabilitation therapy. Surgery is also effective but is traumatic. For this reason, many patients opt for rehabilitation therapy, which results in less long-term trauma and provides certain positive clinical effects (Khaing et al., 2023). Hence, it is widely applied in clinical treatment (Foresti et al., 2024).

Rehabilitation therapy improves clinical symptoms, curbs disease development (Sagtaganov et al., 2024), and plays a positive role in controlling and treating neck and shoulder disorders (Shinde & Bhende, 2023). Based on the principle of statical equilibrium (Özüdoğru et al., 2023), normal cervical physiologic movement and its stability are adjusted through muscles at any time to achieve dynamic balance (Sremakaew et al., 2023). There are a variety of rehabilitation therapies that are widely used to treat neck and shoulder disorders. Static traction is a common treatment method for cervical spondylosis. Unlike dynamic traction, it seldom results in muscular antagonism, allowing patients to relax more easily and experience greater success in treatment (Prentice, 2020). Another therapy used is variable resistance training, which can enhance the speed and strength at the endocentric phase (McEwan et al., 2023). Strength traction can shorten cycle efficiency and improve strength at the endocentric phase. Variable resistance training, when used with static traction, can comprehensively improve neck and shoulder functions and promote rehabilitation. Its effects are remarkable and highly recognized (Yuan et al., 2024). A computer vision-based human posture assessment system can conduct a systematic and comprehensive evaluation of the training effects and provide positive clinical application values (Cronin et al., 2023).

We conducted this research to investigate the application effects of variable resistance training combined with static traction computer vision on neck and shoulder rehabilitation training for college students. We compared the therapeutic effects of static traction and variable resistance training combined with static traction rehabilitation training. In addition, the scores of college students' visual analogue scale (VAS) and Neck Disability Index (NDI) with different training methods were analyzed, and the cervical range of motion and electromyography (EMG) values of college students in different groups were discussed, to provide guidance and reference for the treatment of neck and shoulder disorders and clinical reference for rehabilitation training. While this study provides valuable insights into the rehabilitation of neck and shoulder conditions, several limitations should be acknowledged. First, the sample size was relatively small and limited to a specific population of college students, which may exclude other age groups or individuals with different lifestyles from the generalizability of the findings. Second, the study duration was short term, focusing on immediate post-treatment outcomes; therefore, the long-term sustainability of the observed benefits remains uncertain. The study does not account for potential confounding factors, such as participants' baseline physical activity levels, which could have influenced the results. Finally, the reliance on self-reported measures like the VAS for pain assessment may introduce a subjective bias. Future research should address these limitations by including a larger, more diverse sample, extending the follow-up period, and employing more objective outcome measures.

LITERATURE REVIEW

Neck and shoulder diseases, particularly cervical spondylosis and periarthritis humeroscapularis, are common chronic conditions that affect many individuals. These conditions are often the result of poor posture and a sedentary lifestyle (Wang et al., 2021). They can lead to significant physical and mental distress, impacting the quality of life through persistent pain and functional limitations, and are associated with psychological issues like depression and anxiety (Wu et al., 2022). Various therapeutic approaches have been proposed for managing these conditions, including both pharmacological and non-pharmacological interventions (Perez et al., 2022). Analgesics provide temporary relief but do not address the underlying pathology (Dowlati et al., 2022; Louie et al., 2022). Non-drug therapies, such as surgical interventions and rehabilitation programs, offer more comprehensive solutions. While surgery can be highly effective, it may also be invasive and carry risks, limiting its widespread acceptance (Scheer et al., 2021). Rehabilitation training, on the other hand, presents a less invasive option with proven clinical benefits, making it a popular choice (Yaşa et al., 2021). Additionally, alternative treatments such as acupuncture (Chen et al., 2021) and photobiomodulation therapy (Wu et al., 2022) have shown promise in alleviating symptoms and improving patient outcomes. Research continues to explore innovative techniques, such as cervical resistance training (Taylor et al., 2006) and endoscopic procedures (Wang et al., 2021), to improve the management of these debilitating conditions. The development of new technologies, like semi-supervised support vector machines for brain image fusion (Wan et al., 2021), also holds potential for advancing diagnostic capabilities and guiding personalized treatment strategies.

Although some studies mention the use of technology, such as a computer vision system for posture assessment, there is a gap in understanding how these tools fully integrate into rehabilitation programs and how they affect treatment results. More research that focuses on patient-centered results is needed, such as the effect of treatment on the patient's quality of life and the ability to recover function for daily activities and long-term functional ability. It is necessary not to only focus on the clinical indicators such as range of motion and EMG. This study proves the effectiveness of the combination of static traction and variable resistance training in improving the neck and shoulder rehabilitation effect for college students. This comprehensive method shows significant improvement in pain levels (measured by the VAS) and functional ability (measured by the NDI). This study emphasizes the comprehensive benefits of combined therapy, including an enhanced range of motion of the cervical spine and favorable EMG values, indicating an improvement of muscle strength and activity. This study motivates future research, including exploring the long-term effects and sustainability of comprehensive rehabilitation methods and comparing this treatment with the treatment of other intervertebral disc diseases, which may further improve treatment options.

RESEARCH OBJECTIVES

Utilization by University Administration

The findings of this study can provide valuable insights for university administration to enhance student health and well-being. By demonstrating the effectiveness of the combined rehabilitation approach using static traction and variable resistance training, the study suggests practical strategies for universities to implement in their health and wellness programs. Universities can use these findings to develop tailored rehabilitation protocols for students suffering from painful neck and shoulder conditions, potentially reducing absenteeism, improving academic performance, and enhancing overall student satisfaction. Furthermore, by investing in such programs, universities can differentiate themselves as institutions that prioritize the holistic health of their students, potentially attracting prospective students who value such initiatives. This can also lead to partnerships with healthcare providers and researchers to further refine and expand these programs, ultimately contributing to a healthier campus community.

MATERIALS AND METHODS

Subjects

A total of 90 students who suffered from neck and shoulder conditions and who attended a university in Shanghai from February 2022 to December 2022 were included as subjects, numbered 01 to 90. Then, a computer randomly generated a table of numbers, from which 90 numbers were extracted. The smaller 45 of the 90 numbers were included in the control group, and the rest were included in the observation group. There was no statistical difference in age or years of education between the two groups, which was comparable. Next, the students in the observation group received static traction variable resistance training, and the students in the control group received static traction. The VAS and NDI scores and therapeutic effects were compared between the two groups.

The inclusion criteria follows.

a. The students with complete medical records were included.
b. The students over the age of 18 with normal intellectual and autonomous capacity (without gender restrictions) were included.
c. The students with basic neck and shoulder disorders were included.
d. The students with no history of surgery were included.
e. The students who volunteered to participate in the study and signed an informed consent were included.

The exclusion criteria follows.

a. The students with incomplete medical records were excluded.
b. The students with major organ diseases were excluded.
c. The students with mental disorders or dementia were excluded.
d. The students who were reluctant to participate in the research were excluded.
e. The students who withdrew during the intervention or study period for various reasons were excluded.
f. The students with severe complications and specific physiological changes were excluded.

Methods

Two groups of college students were subjected to static traction using XL-117 elbow flexion and extension trainers. Participants were instructed to wear the trainers using rigging screws to secure the distal end and tighten the buckle in the direction of their elbow dysfunction. For elbow flexion range, the extension angle was $\leq 15°$ and the flexion angle was $\leq 140°$ (tightened once every half hour, twice a day). Elbow flexion and extension therapy was administered in this way for six months. Based on the above exercises, the college students in the observation group also underwent compound variable resistance training, one hour at a time. After a set of squats, the participants performed a burst of strength training by jumping rope and running a 50-meter dash. Moreover, edge computing and an information physics system were adopted for data processing, which improved the real-time analysis, calculation, and control capabilities and met the requirements of the system for fast response.

Observation Indicators

a. The general data for each of the two groups of college students were summarized, including the students' years of schooling, the average age of the students, and their body mass index (BMI) values. The calculation method for BMI is displayed in Equation 1.

$$\text{BMI} = \frac{\text{Weight}}{\text{Height}^2} \quad (1)$$

b. The students' VAS and NDI scores taken before and after treatment were compared between the two groups.
c. The students' degrees of cervical range of motion were measured before and after treatment and compared and analyzed, mainly including the flexion, extension, and rotation angles.
d. The students' EMG values were taken before and after treatment and compared and analyzed, mainly including the values of the sternocleidomastoid and the superior and middle branches of the trapezius.
e. The students' levels of tension and tenderness of soft tissues were assessed before and after treatment and then compared and analyzed.
f. The mean power frequency (MPF) values of the contralateral and affected sides of the students were measured before and after treatment and compared and analyzed, mainly including their head flexion, head back extension, and hands up angles.
g. The median frequency (MF) values of the contralateral and affected sides before and after treatment were compared and analyzed, mainly including the head flexion, head back extension, and hands up angles.
h. The therapeutic effect of each of the two groups of college students was analyzed. Apparent efficiency suggested that the participants' neck and shoulder symptoms notably improved, and their pain was effectively alleviated. Efficiency showed that their neck and shoulder symptoms improved, and their pain was alleviated. No efficiency indicated that their symptoms did not improve or were aggravated, and their pain was not alleviated or was aggravated. The calculation methods for apparent efficiency and efficiency are presented in Equations 2 and 3. Outstanding people, effective number, and total represented the number of cases with apparent efficiency, those with efficiency, and the total number of cases, respectively.

$$\text{Apparent efficiency} = \frac{\text{Outstanding people}}{\text{Total}} \quad (2)$$

$$\text{Efficiency} = \frac{\text{Outstanding people} + \text{Effective number}}{\text{Total}} \quad (3)$$

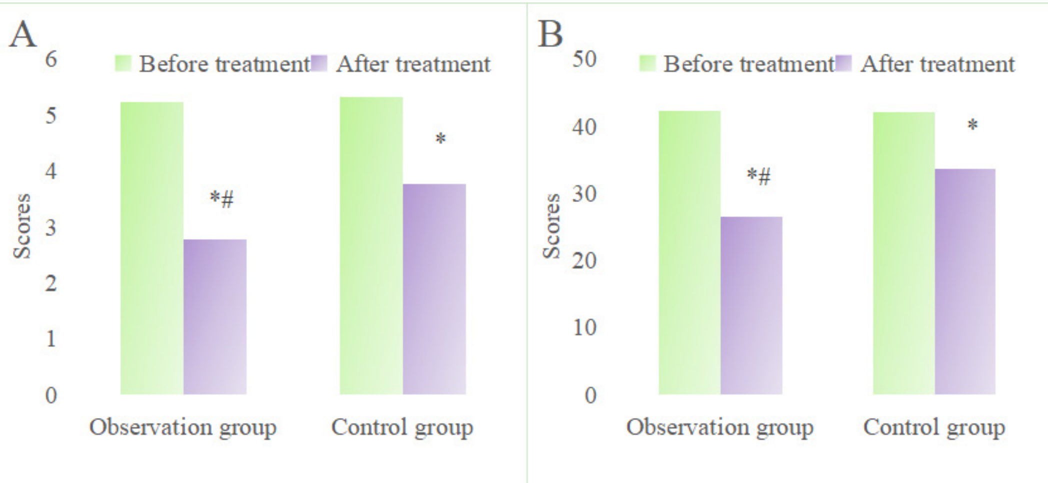
Statistical Processing

Excel 2016 was utilized to record and summarize the data, and SPSS 20.0 was employed for data statistics and analysis. Measurement data were denoted by mean±standard deviation (X±S) using the t test. Enumeration data were denoted by percentage (%) using the X2 test. P<0.05 suggested statistical differences.

Table 1. Comparison of general data between the two groups of student participants

Group	Education (in Years)	Age (in Years)	BMI (kg/m2)	Male / Female
Control group	12.34±3.82	33.66±6.28	22.34±3.12	28/17
Observation group	12.45±3.45	33.18±6.57	22.19±3.28	27/18

Figure 1. Comparison and analysis of VAS and NDI scores before and after treatment



*Note: A. VAS scores B. NDI scores *Results revealed that the difference before and after treatment suggested P<0.05. *#Results revealed that the difference between the two groups demonstrated P<0.05.*

RESULTS

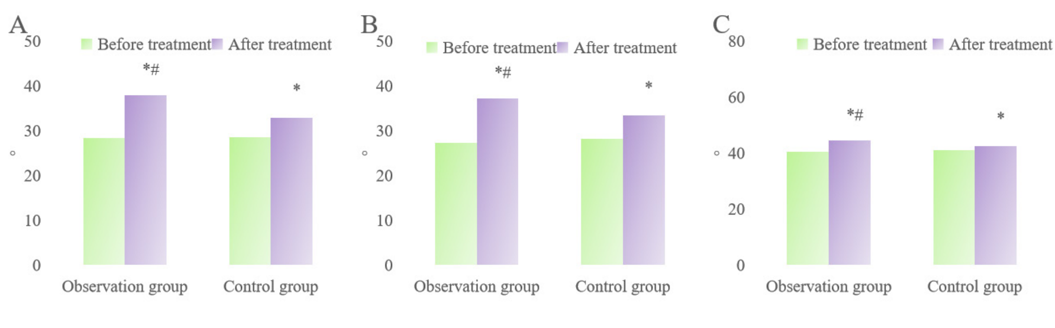
Comparison of General Data Between the Two Groups of College Student Participants

As presented in Table 1, the years of education, average age, BMI, and gender ratio (male to female) of the control and observation groups amounted to 12.34±3.82 vs. 12.45±3.45, 33.66±6.28 vs. 33.18±6.57, 22.34±3.12 kg/m2 vs. 22.19±3.28 kg/m2, and 28/17 vs. 27/18, respectively. There were no statistical differences, but comparability was detected in the above general data between the two groups (P>0.05).

Comparison and Analysis of VAS and NDI Scores Before and After Treatment

Figure 1, A and B, show the participants' VAS and NDI scores, respectively. The VAS scores for the control and observation groups before and after treatment amounted to 5.33 vs. 5.24 and 3.78 vs. 2.78, respectively. Before treatment, no remarkable difference was detected in the VAS scores (P>0.05). After treatment, the VAS scores for each of the two groups notably declined, especially for those of the observation group (P<0.05). The NDI scores for the control and observation groups before and after treatment amounted to 42.16 vs. 42.33 and 33.62 vs. 26.57, respectively. Before treatment, no remarkable difference was detected in the NDI scores (P>0.05). After treatment, the NDI scores for each of the two groups both dramatically declined, especially for those in the observation group (P<0.05).

Figure 2. Comparison and analysis of cervical range of motions before and after treatment



*Note: A. Flexion angles B. Extension angles C. Rotation angles *Results revealed that the difference before and after treatment suggested P<0.05. *#Results revealed that the difference between the two groups demonstrated P<0.05.*

Comparison and Analysis of Cervical Range of Motions Before and After Treatment

Figure 2, A, B, and C, shows the flexion, extension, and rotation angles, respectively. The flexion, extension, and rotation angles of the control and observation groups before and after treatment amounted to 28.49°, 28.11°, and 40.93° vs. 28.36°, 27.32°, and 40.45° and 32.91°, 33.45°, and 42.53° vs. 37.88°, 37.22°, and 44.38°, respectively. There was no significant difference in the above angle between the two groups before treatment ($P>0.05$). After treatment, the above angles of the student participants in both groups increased significantly, especially in the observation group ($P<0.05$).

Comparison and Analysis of EMG Values Before and After Treatment

Figure 3, A, B, and C, shows the sternocleidomastoid EMG values, the EMG values of the superior branch of the trapezius, and the EMG values of the middle branch of the trapezius, respectively. The sternocleidomastoid EMG values and EMG values of the superior and middle branches of the trapezius of the control and observation groups before and after treatment amounted to 8.87, 14.92, and 16.44 vs. 8.92, 14.78, and 16.93 and 7.29, 9.83, and 13.75 vs. 5.03, 8.19, and 11.27, respectively. No notable differences were detected in the above values between the two groups before treatment ($P>0.05$). After treatment, the above measurements of the students' EMG values in both groups decreased significantly, especially in the observation group ($P<0.05$).

Comparison and Analysis of Tension and Tenderness Values of Soft Tissues Before and After Treatment

Tables 2 and 3 and Figure 4, A and B, show the tension and tenderness soft tissues values for each group of participants. Before treatment, the tension (contralateral and affected sides) and tenderness (contralateral and affected sides) values of the control and observation groups amounted to (6.89 mm, 5.89 mm) vs. (6.74 mm, 5.92 mm) and (2.53 kg, 2.08 kg) vs. (2.67 kg, 2.03 kg), respectively. After treatment, the above values for the student participants' contralateral and affected sides of the two groups amounted to (7.13 mm, 6.49 mm) vs. (7.28 mm, 6.87 mm) and (2.61 kg, 2.43 kg) vs. (2.77 kg, 2.59 kg), respectively. No dramatic differences were detected in the above values between the two groups before treatment ($P>0.05$). After treatment, both groups' values notably increased, especially those of the observation group ($P<0.05$).

Comparison and Analysis of MPF Before and After Treatment

As illustrated in Table 4 and Figure 5, the MPF values of the head flexion at the contralateral and affected sides of the control and observation groups before and after treatment amounted to

Table 2. Comparison and analysis of tension values before and after treatment

Group		Observation Group (mm)	Control Group (mm)
Contralateral	Before Treatment	6.74	6.89
	After treatment	7.28	7.13
Affected side	Before treatment	5.92	5.89
	After treatment	6.87	6.49

Table 3. Comparison and analysis of tenderness values before and after treatment

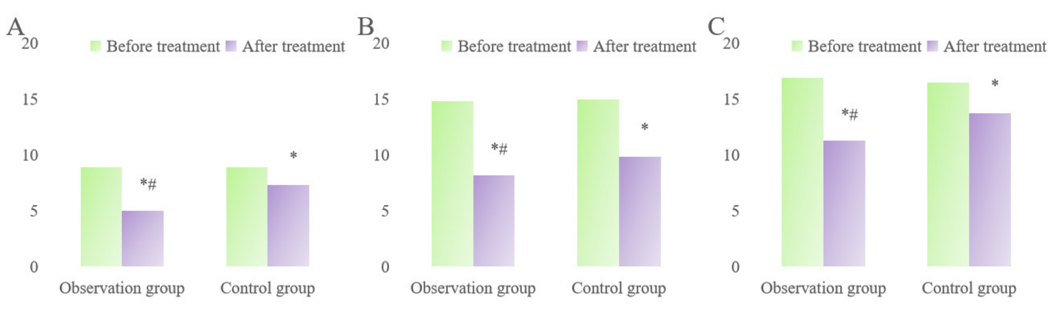
Group		Observation Group (Kg)	Control Group (Kg)
Contralateral	Before Treatment	2.67	2.53
	After treatment	2.77	2.61
Affected side	Before treatment	2.03	2.08
	After treatment	2.59	2.43

(114.67 Hz, 77.92 Hz) vs. (113.78 Hz, 78.35 Hz) and (122.35 Hz, 91.69 Hz) vs. (126.67 Hz, 99.33 Hz), respectively. The head back extension MPF values of the contralateral and affected sides of each of the two groups amounted to (113.95 Hz, 76.52 Hz) vs. (114.67 Hz, 77.34 Hz) and (114.78 Hz, 89.38 Hz) vs. (115.23 Hz, 81.22 Hz), respectively. The hands up MPF values for the contralateral and affected sides of each of the two groups amounted to (64.49 Hz, 61.07 Hz) vs. (65.27 Hz, 61.27 Hz) and (65.18 Hz, 61.87 Hz) vs. (67.24 Hz, 62.97 Hz), respectively. No notable differences were detected in the MPF values of the different movements between the two groups before treatment ($P>0.05$). After treatment, the MPF values of all movements in the two groups apparently increased, especially those in the observation group ($P<0.05$).

Comparison and Analysis of MF Values Before and After Treatment

As displayed in Table 5 and Figure 6, the MF values of the head flexion at the contralateral and affected sides of the participants in the control and observation groups before and after treatment amounted to (83.13 Hz, 40.03 Hz) vs. (82.57 Hz, 39.25 Hz) and (89.33Hz, 43.59 Hz) vs. (92.36 Hz,

Figure 3. Comparison and analysis of EMG values before and after treatment



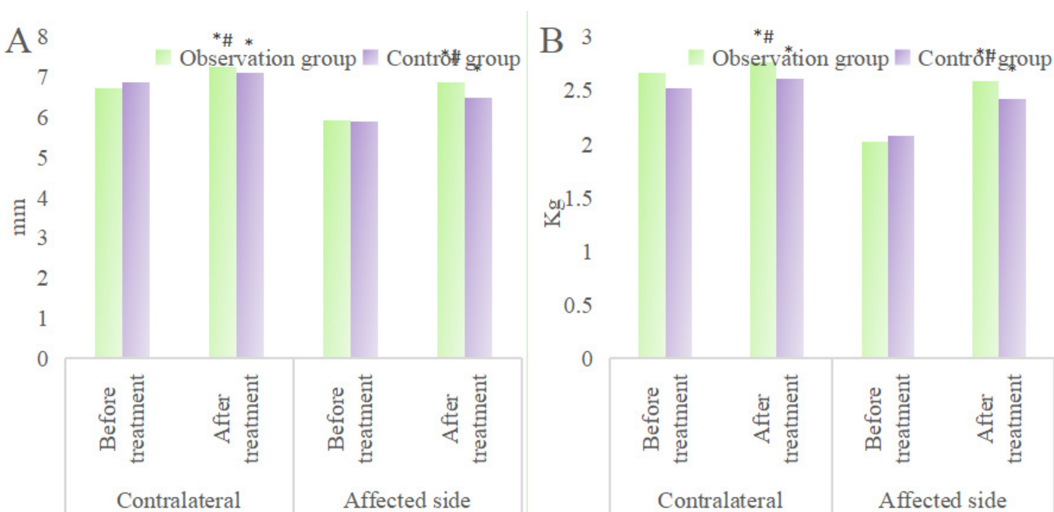
*Note: A. Sternocleidomastoid EMG values B. EMG values of the superior branch of the trapezius C. EMG values of the middle branch of the trapezius *Results revealed that the difference before and after treatment suggested P<0.05. *#Results revealed that the difference between the two groups demonstrated P<0.05.*

Table 4. Comparison and analysis of MPF values before and after treatment

Group			Observation Group (Hz)	Control Group (Hz)
Head flexion	Contralateral	Before treatment	113.78	114.67
		After treatment	126.67	122.35
	Affected side	Before treatment	78.35	77.92
		After treatment	99.33	91.69
Head extension	Contralateral	Before treatment	114.67	113.95
		After treatment	115.23	114.78
	Affected side	Before treatment	77.34	76.52
		After treatment	81.22	89.38
Hands up	Contralateral	Before treatment	65.27	64.49
		After treatment	67.24	65.18
	Affected side	Before treatment	61.27	61.07
		After treatment	62.97	61.87

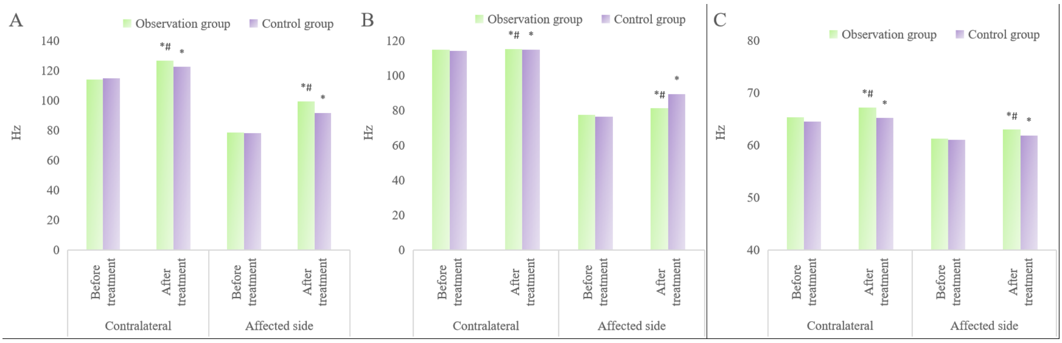
47.26 Hz), respectively. The MF head back extension values of the contralateral and affected sides of the participants in each of the two groups before and after treatment amounted to (75.22 Hz, 34.28 Hz) vs. (74.18 Hz, 33.27 Hz) and (74.79 Hz, 40.74 Hz) vs. (73.37 Hz, 45.98 Hz), respectively. The hands up MF values of the contralateral and affected sides of each of the two groups amounted to (21.04 Hz, 19.62 Hz) vs. (20.33 Hz, 19.03 Hz) and (22.85 Hz, 20.15 Hz) vs. (24.05 Hz, 22.26 Hz), respectively. No notable differences were detected in the MF values of all the movements between the two groups before treatment (P>0.05). After treatment, the MF values of the two groups apparently increased, especially those of the observation group (P<0.05).

Figure 4. Comparison and analysis of tension and tenderness values of soft tissues before and after treatment



*Note: A. Tension values B. Tenderness values *Results revealed that the difference before and after treatment suggested P<0.05. *#Results revealed that the difference between the two groups demonstrated P<0.05.*

Figure 5. Comparison and analysis of MPF values before and after treatment



*Note: A. Head flexion B. Head back extension C. Hands up *Results revealed that the difference before and after treatment suggested P<0.05. *#Results revealed that the difference between the two groups demonstrated P<0.05.*

Table 5. Comparison and analysis of MF values before and after treatment

Group			Observation Group (Hz)	Control Group (Hz)
Head flexion	Contralateral	Before treatment	82.57	83.13
		After treatment	92.36	89.33
	Affected side	Before treatment	39.25	40.03
		After treatment	47.26	43.59
Head extension	Contralateral	Before treatment	74.18	75.22
		After treatment	73.37	74.79
	Affected side	Before treatment	33.27	34.28
		After treatment	45.98	40.74
Hands up	Contralateral	Before treatment	20.33	21.04
		After treatment	24.05	22.85
	Affected side	Before treatment	19.03	19.62
		After treatment	22.26	20.15

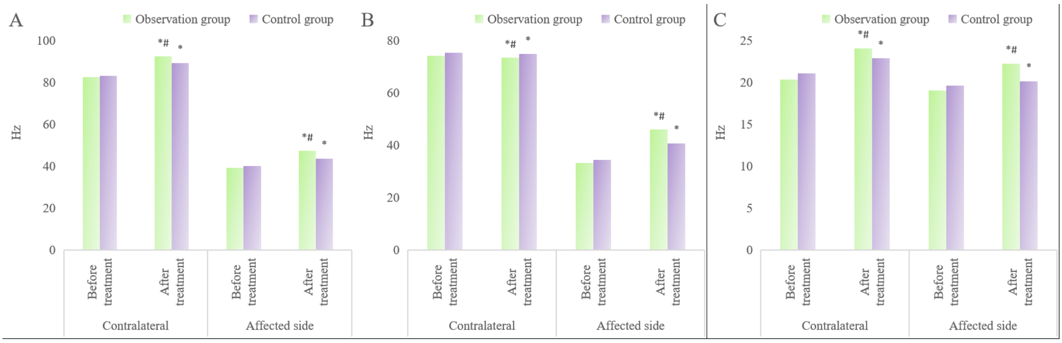
Comparison and Analysis of Therapeutic Effects on the Control and Observation Groups

As presented in Table 6, the number of cases with significant effect, valid and invalid cases, apparent efficiency, and efficiency of the control and observation groups amounted to 17 vs. 22, 15 vs. 19, 13 vs. 4, 37.78% vs. 48.89%, and 71.11% vs. 91.11%, respectively. The treatment was effective for both groups of student participants. The apparent efficiency and efficiency of the observation group were higher (P<0.05).

Relationship to Computer Vision Support and Decision-Making

The integration of computer vision support in the rehabilitation process played a pivotal role in enhancing the effectiveness of the evaluated methods and informing decision-making. Computer vision systems were utilized to accurately assess and monitor the posture and movements of the participants during the rehabilitation sessions. This technology allowed for real-time feedback and adjustments,

Figure 6. Comparison and analysis of MF values before and after treatment



*Note: A. Head flexion. B. Head back extension C. Hands up *Results revealed that the difference before and after treatment suggested P<0.05. *#Results revealed that the difference between the two groups demonstrated P<0.05.*

Table 6. Comparison and analysis of therapeutic effects on the control and observation groups

Group	Significant Effect (n)	Valid (n)	Invalid (n)	Apparent Efficiency (%)	Efficiency (%)
Control group (n=45)	17	15	13	37.78	71.11
Observation group (n=45)	22	19	4	48.89	91.11

ensuring that the participants performed the exercises correctly and safely. The quantitative data obtained from computer vision analysis provided objective measurements of progress, which were crucial for adjusting the rehabilitation protocols based on the participants' individual needs. Computer vision systems were specifically designed to analyze the participants' posture and movement patterns, identifying deviations from optimal form and providing immediate corrective feedback. This not only helped in maintaining the integrity of the rehabilitation exercises, but also minimized the risk of injury due to incorrect technique. The data collected through computer vision was analyzed to track the participants' progress over time, allowing healthcare providers to make informed decisions regarding the progression or modification of each student's rehabilitation plan.

Moreover, the use of computer vision support facilitated a data-driven approach to decision-making. The quantitative data from the computer vision system was integrated with the clinical assessments, such as the VAS and the NDI, to provide a comprehensive view of the participants' conditions. This multidimensional data set enabled healthcare providers to tailor the rehabilitation plans for the individual participants more precisely, taking into account both the subjective patient reports and objective measurements of physical function and posture. By leveraging computer vision technology, the rehabilitation process became more efficient and personalized. The real-time feedback and objective measurements provided by computer vision systems allowed healthcare providers to adjust the rehabilitation protocols in response to individual progress, ensuring that the participants received the most effective treatment possible. This data-driven approach not only optimized the rehabilitation process but also empowered the decision-making process, leading to more personalized and effective treatment strategies for the participants.

DISCUSSION

Patients with neck and shoulder disorders often suffer from cervical vertebrate and shoulder pain, and their range of head movement is limited (Crane, 2023), which seriously affects their everyday life (Garg et al., 2024). These patients should perform professional and persistent rehabilitation training for the gradual restoration of their neck and shoulder functions so they can return to living a normal life. Static traction is an effective therapy for neck and shoulder disorders (Agarwal et al., 2024). It is aimed at alleviating cervical vertebrate pain and promoting the rehabilitation of intervertebral disc tissue based on the functions of the cervical vertebrate. Variable resistance training is a comprehensive, compound rehabilitation training method that promotes gradual recovery more reasonably. Rehabilitation training focuses on the combination of dynamic extension and explosive training to avoid injury and even disease aggravation caused by excessive exercise. Patients suffering from these types of conditions should perform moderate and reasonable training for the recovery of their neck and shoulder functions. Static traction combined with variable resistance training notably enhances patients' comfort, reduces pain during the training, and improves training enthusiasm (Mudassar et al., 2023). Therefore, it is widely supported by patients of clinical practicians and who possess high clinical application values. In this research, the effects of static traction and combined therapy on neck and shoulder rehabilitation training among college students were compared. The VAS and NDI scores of two groups of college students were analyzed. The participants' cervical range of motion angles, EMG values, tenderness and tension values, MPF values, and MF values in the two groups were also explored.

According to the research findings, the VAS and NDI scores for control and observation groups before and after treatment amounted to (5.33, 42.16) vs. (5.24, 42.33) and (3.78, 33.62) vs. (2.78, 26.57), respectively. After treatment, the flexion, extension, and rotation angles and the tension and tenderness, MPF, and MF values of both groups all dramatically increased, while the sternocleidomastoid values and the EMG values of the superior and middle branches of the trapezius notably declined, especially those in the observation group. Static traction plays a positive role in treating cervical spondylosis. Gillani et al. (2020) compared the therapeutic effects of metomyocyte energy technology and static traction with cervical vertebrate segment exercise therapy on upper crossed syndrome patients and found that the combined therapy was relatively more effective in relieving pain, improving cervical range of motion, and reducing the incidence of neck disability. Osama and Rehman (2020) analyzed the impacts of static extension, autoinhibition, and reciprocal inhibition on pain, disability, and range of motion among patients with mechanical neck pain. They demonstrated that static traction apparently alleviated pain, diminished disability, and expanded range of motion. The technique showed remarkable clinical effects. Mahmoud et al. (2020) analyzed the influences of three continuous-end neck rotations with different durations of vertebral artery hemodynamics in static traction and found that static traction lasting for 60 seconds led to a notable improvement of vertebral artery hemodynamics. Ruivo et al. (2017) assessed the effects of a 16-week variable resistance training program performed in PE classes on forehead position and permanent shoulder position among Portuguese teenagers. They found that the angles of the neck and shoulders of the teenagers in the intervention group dramatically improved from the beginning to the end of the test. The 16-week resistance and stretching training reduced the occurrence of adverse forehead and permanent shoulder positions.

Finally, in this study, the clinical therapeutic effects of different treatment methods were evaluated. The number of valid cases with significant effect, apparent efficiency, and efficiency of control in the observation group amounted to 17 vs. 22, 15 vs. 19, 37.78% vs. 48.89%, and 71.11% vs. 91.11%, respectively. These results indicate that variable resistance training can significantly improve the position of the neck and shoulder, so it can be applied to college students with painful neck and shoulder disorders. In addition, the results suggest that rehabilitation training based on variable resistance training with static traction has greater advantages in the treatment of neck and shoulder disorders and has a positive application value in relieving pain and improving neck and shoulder function.

CONCLUSION

The present study aimed to evaluate the effectiveness of a combined rehabilitation protocol that integrates static traction with variable resistance training for college students with neck and shoulder disorders. The findings demonstrate significant improvements in pain reduction, as measured by the VAS, and functional ability, as measured by the NDI. Additionally, there were favorable changes in the cervical range of motion angles and electromyography values, indicating improved muscle strength and mobility. The integration of computer vision support in the rehabilitation process played a pivotal role in enhancing the effectiveness of the evaluated methods and informing decision-making. Computer vision systems allow for real-time feedback and adjustments, ensuring correct exercise execution and minimizing the risk of injury. The quantitative data obtained from computer vision analysis provided objective measurements of progress, which were crucial for tailoring the rehabilitation protocols based on the individual needs of the participants. The use of computer vision support facilitated a data-driven approach to decision-making, enabling healthcare providers to adjust the rehabilitation protocols in response to each participant's individual progression rate. This data-driven approach optimized the rehabilitation process, leading to more personalized and effective treatment strategies for the participants.

The findings of this study can provide valuable insights for university administration to enhance student health and well-being. By demonstrating the effectiveness of the combined rehabilitation approach using static traction and variable resistance training, the study suggests practical strategies for universities to implement in their health and wellness programs. Universities can utilize these findings to develop tailored rehabilitation protocols for students suffering from neck and shoulder disorders, potentially reducing absenteeism, improving academic performance, and enhancing overall student satisfaction. While the study provides valuable insights, it is important to acknowledge several limitations. The study primarily involved college students, which may limit the generalizability of the findings to other populations. The duration of the follow-up was relatively short, which may not adequately capture the long-term effects and sustainability of the combined rehabilitation approach. Additionally, the reliance on self-reported measures, such as the VAS and the NDI values, may not fully capture all aspects of functional improvement.

Future research should address these limitations to further validate the effectiveness of the combined rehabilitation approach and explore its applicability to broader populations. Overall, the study contributes to the growing body of evidence supporting the use of combined rehabilitation protocols and computer vision support for the treatment of neck and shoulder disorders, offering practical strategies for enhancing student health and well-being at the university level.

AUTHOR NOTE

The authors of this publication declare there are no competing interests. This work was supported by Shanghai Educational Science Research Project, 2022, research on Experimental Study on the Intervention of Static Draft Combined with Resistance Training on Neck shoulder Syndrome in College Students (Project No. C2022153). This paper includes research data to support the results of this study. The authors would like to show sincere thanks to those techniques who have contributed to this research.

PROCESS DATES

This manuscript was initially received for consideration for the journal on 07/17/2024, revisions were received for the manuscript following the double-anonymized peer review on 08/19/2024, the manuscript was formally accepted on 8/29/2024, and the manuscript was finalized for publication on 10/7/2024.

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