RESEARCH PAPER

Effect of Proprioceptive Motor Training on the Craniovertebral Angle in Young Adults with Forward Head Posture: A Systematic Review of Randomized Controlled Trials

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ABSTRACT

Background:

Forward head posture (FHP) is a prevalent musculoskeletal deviation among young adults, associated with altered cervical biomechanics, impaired proprioception, and reduced craniovertebral angle (CVA). Proprioceptive motor training (PMT) has emerged as a targeted intervention addressing sensorimotor deficits; however, its effectiveness relative to conventional therapies remains unclear.

Objective:

This systematic review aimed to evaluate the efficacy of PMT in improving CVA and related functional outcomes in young adults with FHP.

Methods:

A systematic search of PubMed, Scopus, Web of Science, PEDro, Embase, and Cochrane CENTRAL was conducted in accordance with PRISMA 2020 guidelines. Randomized controlled trials involving individuals aged 18–35 years with FHP were included. Interventions comprised PMT modalities such as joint position sense training, oculomotor exercises, and sensorimotor retraining, compared with conventional physiotherapy or control conditions. Primary outcome was CVA; secondary outcomes included joint position error (JPE), pain intensity, and disability. Methodological quality was assessed using the PEDro scale, and risk of bias was evaluated using Cochrane RoB 2.

Results:

Six studies met inclusion criteria. PMT, particularly when combined with corrective or stabilization exercises, demonstrated significant improvements in CVA and proprioception. Multimodal interventions yielded the largest postural corrections. Secondary outcomes, including pain reduction and functional improvement, also showed consistent enhancement. Methodological quality ranged from moderate to good (PEDro scores 5–7/10), with some concerns regarding blinding and allocation concealment.

Conclusion:

PMT is an effective intervention for improving postural alignment and sensorimotor function in young adults with FHP, especially when integrated into multimodal rehabilitation programs. Further high-quality trials with standardized protocols are warranted.

Keywords: Forward head posture, Craniovertebral angle, Proprioceptive motor training, Young adults, Systematic review

How to cite this article: Sharma T, Trivedi N. Effect of Proprioceptive Motor Training on the Craniovertebral Angle in Young Adults with Forward Head Posture: A Systematic Review of Randomized Controlled Trials. Int J Drug Deliv Technol. 2026;16(39s): 679-688. DOI: 10.25258/ijddt.16.39s.87

Source of support: Nil.

Conflict of interest: None

Introduction

Foward head posture (FHP) has become a very common postural deviation among the young adult population, and

this has been as a result of prolonged usage of smartphones, laptops, and other electronic devices (2). Modern epidemiology shows prevalence rates, between 11.4 and 67 percentage in young adults and as high as 68 in adolescents, which is a significant and increasing health issue to the population (2). FHP is biomechanically described as anterior head movement in the sagittal plane compared with the trunk, which is usually accompanied with a compensatory extension of the upper cervix and an increase in thoracic kyphosis (1). This displacement augments compressive and shear stresses on cervical structures, and alters muscular length, tension links, as well as neuromuscular imbalance, setting persons up to neck pain, cervical degeneration, temporomandibular dysfunction, and impaired respiratory mechanics (2).

FHP is most often quantified using a craniovertebral angle (CVA), which is a photogrammetric measure that is validated and is the intersection of a horizontal line through the C7 spinous process and a line between C7 and the ear tragus (1). The reduced values of CVA rate represent the higher rates of anterior head translation and postural deviation (1). Having a wide clinical and research usage, there are still gaps in the area of CVA cutoff values and standardized assessment positions (1). Nevertheless, CVA is the most important measure of outcome in studies that explore postural correction interventions (1). In addition to structural malalignment, FHP is greatly linked with cervical sensorimotor control disruptions (5). The cervical spinal cord contains a high density of mechanoreceptors especially in the deep suboccipital muscles that combine with the vestibular and visual systems to monitor the position of the joint, gaze stability, and postural balance (5). It has been found that altered cervical afferent stimulation in patients with neck dysfunction is associated with a lack of joint position sense (JPS), oculomotor control, and postural stability (5). The consistent review of proprioceptive treatments proves that specific sensorimotor retraining, such as deep cervical flexor activities and eye-head coordination trains, would subsequently result into moderate to huge gains in the position sense and pain alleviation (3).

Traditional intervention strategies towards FHP have comprised of postural education (PE), stretching, strengthening and multimodal corrective exercise programs (CEPs) (2). Evidence, albeit randomly controlled, indicates that PE as well as CEPs have a potential to considerably better CVA after short intervention sessions, and that both self-myofascial release, stretching, and strengthening approaches are more effective than education (2). However, more recently, it has been demonstrated that corrective intervention involving the use of postural correction exercises (PCEs), scapular stabilization exercises (SSEs), and supplementary adjunctive mechanisms like kinesiotaping leads to considerable improvements in CVA and other functional outcomes (4).

Similar lines of research highlight the benefits of the proprioceptive motor training (PMT)-such as the cervical joint position sense retraining, gazes stability exercises and the craniocervical flexor training (CCFT)-to restore neuromuscular control (3,5). Proprioceptive training has been shown to be better than alternative approaches in terms of improving the sense of position of the joint and the stability of the overall balance, whereas CCFT improves the strength of the deep cervical flexor and pain mitigation in college students with smartphone-related neck dysfunction (6). Moreover, there are also new technologies like virtual reality-based sensorimotor training that have shown clinically significant pain relief of the neck and proprioception of the neck in patients with FHP (7).

Even though there is increased evidence on the effectiveness of both structural corrective and sensorimotor-based interventions, the literature is still disjointed. Compared to conventional physiotherapy strategies, direct comparisons between proprioceptive motor training programs and conventional physiotherapy strategies are few and the correlation between structural postural correction (measured by CVA) and secondary outcomes, such as joint position error (JPE), neck disability, and pain intensity, have not been synthesized (2,3,6). Moreover, differences in the content of interventions, dosage and outcome reporting make the process of clinical decision-making more complicated.

Based on this, the general aim of the systematic review is to determine the efficacy of the proprioceptive motor training programs in the enhancement of the craniovertebral angle in young adults who have been diagnosed with forward head posture. The aim of the review is to establish whether PMT, such as joint position sense training, oculomotor exercise, cervical stabilization with sensory feedback, and sensorimotor activities performed in virtual reality can be superior in terms of postural correction to conventional physiotherapy interventions, ergonomic education, sham exercises or no intervention (2,3,6,7). The most important outcome of

interest is a change in craniovertebral angle measured through validated photogrammetry of goniometry (1). Joint position error (JPE), Neck Disability Index (NDI) scores, and pain intensity as measured with the Visual Analog Scale (VAS) are the secondary outcomes (3,6,7). The synthesis of existing randomized and controlled evidence in a PICO framework will help to understand the relative effectiveness and safety of proprioceptive motor training interventions and guide evidence-based rehabilitation in case of young adults with forward head posture.

Methods

This systematic review was done following the PRISMA 2020 statement and designed according to the pre-specified protocol. The PICO framework was used to formulate the review question to make it rigorous and to make sure that it is methodologically sound and transparent.

Eligibility Criteria

The protocol had predetermined eligibility criteria which are as follows.

Study Design

Randomized controlled trials (RCTs) were selected to guarantee the best level of evidence and reduce the biases of selection.

Participants

The studies were to be eligible when participants:

- Were young adults aged 18-35 years
- Clinically determined disorders: forward head posture.
- exhibited a lower craniovertebral angle (CVA) where the study-specific diagnostic threshold was under diagnostic threshold.
- Mean proportion reported baseline CVA determined through photogrammetry or goniometry.
- Participants were excluded based on the exclusion criteria of studies of patients with systemic musculoskeletal illnesses, neurological illnesses, a recent cervical trauma or surgery, or gross spinal deformities.

Interventions

The following interventions were considered for the review:

- Proprioceptive motor training (PMT)
- Sensorimotor training
- Neuromuscular re-education
- Sense of Cervical joint position (JPS) training.
- The coordination training of the eye-hand or eye-head.
- Biofeedback cervical stabilization.
- Sensorimotor tasks in Virtual reality.

Studies, in which the proprioceptive training was inseparable with the pharmacological or surgical ones, were eliminated.

Comparator

Comparators included:

- Classical physiotherapy (stretching, strengthening)
- Ergonomic education
- Sham exercise
- No intervention (control)

Outcomes

Primary Outcome:

- Change in craniovertebral angle (CVA)

Secondary Outcomes:

- Joint position error (JPE)
- Neck Disability Index (NDI)
- Intensity of pain (Visual Analog Scale - VAS)

Studies also needed to state pre-and post-intervention means and standard deviations or have data indicating information on which to determine the effects.

Language and Publication Status

The articles were limited to full-text articles published in English.

Information Sources

The search was performed by the whole database since the inception of the databases until the latest search date in:

- PubMed/MEDLINE
- Cochrane CENTRAL
- Embase (Ovid)
- PEDro
- Scopus
- Web of Science

Through grey literature was searched.

- ClinicalTrials.gov
- WHO International Clinical Trials Registry Platform.
- Included studies and pertinent systematic reviews had reference lists that were manually filtered.

Search Strategy

The search strategies were a combination of MeSH terms and free-text words pertaining to FHP, proprioception, and randomized trials.

Sample query PubMed search query:

("Forward Head Posture" OR "Craniovertebral Angle" OR "CVA") AND (proprioception" (proprioceptive training" OR sensorimotor training" OR neuromuscular re-education) And (randomized Controlled Trial))

Search techniques were revised several times in order to maximize sensitivity.

Selection Process

A two-stage screening was done with study selection:

Stage 1: Title and Abstract Screening Two reviewers selected all titles and abstracts. The discrepancies were solved through discussion or consultation with a third reviewer.

Stage 2: Full-Text Assessment Full texts of possible eligible studies were formally evaluated independently. The causes of exclusion were also noted down and listed in a PRISMA flow diagram.

Data Collection Process

Two reviewers, using a pilot tested, standardized, extraction form, conducted data extraction independently.

Extracted data included:

- Identification of the studies.
- Trial design and setting
- Participant characteristics and sample size.
- Baseline CVA
- Type of intervention, intervention frequency, time, equipment.
- Comparator details
- Result measures and statistical findings.
- Financing needs and conflict of interests.

Backing decisions was an outcome of unanimity.

Risk of Bias Assessment

Several risk of bias instruments are considered stochastic models. Several risk of bias instruments are viewed as stochastic models.

All the incorporated studies were appraised in five domains:

- Randomization process
- The nonconformity to planned interventions.
- Missing outcome data
- Measurement of the outcome
- Choosing of reported result.

Each domain was rated as:

- Low risk
- Some concerns
- High risk

PEDro Scale

Physiotherapy methodological quality was assessed by the use of PEDro scale and this included:

- Random allocation
- Concealed allocation
- Baseline similarity
- Blinding (assessors, therapists, subjects)
- Intention-to-treat analysis
- Between-group comparisons

High methodological quality was regarded as a score 6/10.

Data Synthesis

Synthesis Approach

A narrative synthesis is a type of synthesis because of expected heterogeneity of clinical and methodological interventions protocols and measurement procedures according to the SWiM (Synthesis Without Meta-analysis) reporting tool.

Grouping of Studies

A classification of the studies was based on the type of intervention:

- Head relocation / JPS training.
- Coordination training: Oculomotor / eye-head.
- Biofeedback-assisted stabilization
- Interventions based on virtual reality.

Effect Size Calculation

Data allowing it were used to compute standardized effect sizes (Hedges g) of change in CVA.

The heterogeneity of populations among the ABCs of Australia under discussion is explored.

The moderators were analyzed as follows:

- Doses of training (sum of the number of sessions and the duration of sessions)
- Position of measure (sitting vs standing CVA)
- Subpopulation (students vs IT professionals)
- Classification Proprioceptive stimulus.

Certainty of Evidence

The assessment of the certainty of evidence of the main outcome (CVA change) was performed on the basis of GRADE approach and it took into consideration:

- Risk of bias
- Consistency
- Directness
- Precision
- Publication bias

Evidence was rated as:

- High
- Moderate

- Low
- Very low

Ethical Considerations

This review did not utilize new human participant data. The ethical integrity was practiced through the synthesis of those studies that have reported authorization of ethical methods through institutions and informed consent procedures.

Results

Study Selection

The PRISMA 2020 guidelines were adhered to in the process of selecting the study. In total, 318 records were identified in the beginning by the database search and other sources. Upon elimination of duplicates, 294 records underwent screening according to title and abstract, 251 of them were eliminated. Such articles were evaluated on the basis of eligibility (n=43) and 37 articles were excluded because of the non-RCT design, the wrong population, non-proprioceptive intervention, or lack of outcome data. Lastly, the qualitative synthesis involved the inclusion of six randomized or controlled experimental studies.

PEDro Scale Assessment of Included Studies

To analyze the quality of the methodology used in randomized and controlled studies contained in this systematic review, the PEDro (Physiotherapy Evidence Database) scale was used to assess the quality of the papers. The PEDro scale has 11 items (One of the items is concerned with external validity and is not part of the final score). Thus, research work is rated out of 10 according to the internal validity and statistical reporting (Table 1).

Table 1: PEDro Quality Assessment of Included Studies

Study	2	3	4	5	6	7	8	9	10	11	PEDro Score (/10)	Quality Level
Elgendy et al., 2024	✓	✓	✓	✗	✗	✓	✓	✗	✓	✓	7/10	Good
Özalp et al., 2025	✓	✓	✓	✗	✗	✓	✓	✗	✓	✓	7/10	Good
Izquierdo et al., 2016	✓	✗	✓	✗	✗	✓	✓	✗	✓	✓	6/10	Moderate
Giridharan et al., 2025	✓	✗	✓	✗	✗	✗	✓	✗	✓	✓	5/10	Moderate
Titcomb et al., 2023	✓	✓	✓	✗	✗	✗	✓	✗	✓	✓	6/10	Moderate–Good
Goo et al., 2024	✓	✗	✓	✗	✗	✗	✓	✗	✓	✓	5/10	Moderate

All in all, the quality of methodology used in the included studies was moderate to good (PEDro Scores: 5-7/10). The majority of the trials sufficiently described random assignment, baseline comparability, and statistical comparisons. Nevertheless, participant and therapist blinding was extensively not applied as in exercise-based physiotherapy trials. Hidden assignment and assessor blinding were not consistently reported thus rendering moderate risk of performance and detection bias in a number of studies.

These PEDro results suggest that the scientific foundation of forward head posture using proprioceptive motor training is methodologically sound yet could be strengthened in future studies by introducing stricter methods of allocation concealment, blinded outcome assessment and intention-to-treat analysis to enhance internal validity.

Study Characteristics

The articles included were either randomized controlled, or experimental studies assessing corrective, stabilization or proprioceptive training programs in young adults or adults with neck dysfunction to evaluate forward head posture (FHP). The size of the samples was between 28 and 99 participants, the intervention period was between 4 and 8 weeks or even 2 months. Main outcomes in studies comprised of craniovertebral angle (CVA), proprioception (joint position error), balance, pain and disability indicators. The exercise-based rehabilitation programs used in most of the studies included corrective exercise programs, cervical stabilization exercises, proprioceptive training, multimodal protocols, which incorporated exercises with taping or visual feedback. Table 2 summarizes these characteristics.

Table 2. Study Characteristics

Author (Year)	Study Design	Participants (n, age)	Intervention	Comparator	Duration	Primary Outcomes

Elgendy et al., 2024	RCT (4-arm parallel)	n=60, 18–40 yrs with FHP	PCEs + SSEs + Kinesiotaping	PCEs alone / PCE+SSE / PCE+KT	4 weeks	CVA, scapular position, hand grip strength
Özalp et al., 2025	Single-blind RCT	n=99, 18–24 yrs with FHP	Cervical stabilization + proprioception training	CSE alone / Control	6 weeks	CVA, balance, proprioception (JPE)
Izquierdo et al., 2016	RCT clinical trial	n=28 chronic neck pain	Cranio-cervical flexion vs proprioception training	Comparison of 2 exercise approaches	2 months	CCFT performance, pain, disability
Giridharan et al., 2025	Experimental study	n=30 students with FHP	VR-based training	Proprioceptive training	8 weeks	Neck pain, proprioception (JPE)
Titcomb et al., 2023	RCT (4-arm)	n=79 young adults with FHP	Corrective exercise programs (SMR+stretching±strengthening)	Postural education / Control	4 weeks	Craniovertebral angle (CVA)
Goo et al., 2024	Randomized experimental trial	n=30 adults with FHP	Cervical stabilization + visual feedback	Stabilization without feedback	Not specified	CVA, proprioception

Effects on Craniovertebral Angle (CVA)

All the trials included showed an increase in craniovertebral angle after intervention. A randomized study using four arms was used to show statistically significant CVA improvements in all groups that received postural correction exercises (PCEs) with the highest improvement rate being in the combined PCEs, scapular stabilization exercises (SSEs), and kinesiotaping group ($p < 0.05$) [4]. Equally, a randomized trial that studied the effectiveness of cervical stabilization exercises revealed significant post-intervention CVA relative to pre-intervention especially when proprioception training was in association with stabilization exercises ($p \leq 0.03$) [8].

Self-myofascial release exercises, stretching exercises and strengthening exercises, which constituted a corrective exercise program also provided significant benefits in CVA after 4 weeks, as compared to control groups ($p < 0.01$) [2]. These results show that multimodal or strengthening-based corrective exercises are more posturally corrective compared to education only.

An experiment evaluating the effects of visual feedback in cervical stabilization also established significant changes in CVA and proprioception in cervical stabilization exercises with visual feedback over that with no feedback ($p < 0.05$), which was considered an advantage of augmented sensory input in rehabilitation [9]. In general, the findings are consistently encouraging to conclude that the benefits of corrective exercise, stabilization, and a combination of sensorimotor interventions include a clinically significant change in CVA, which indicates the presence of better head and neck positioning.

Effects on Proprioception and Balance

There were a number of studies that specifically tested sensorimotor outcomes. Cervical stabilization in combination with proprioception training was found to greatly decrease the amount of error in positioning the joint and also enhanced the state of dynamic balance in comparison to stabilization or control ($p < 0.001$) [8]. On the same note, neuromuscular control and pain and disability showed improvement after proprioceptive training methods encountered in a two monthly period contrary to differences made between cranio- cervical flexion and proprioception training groups ($p = 0.05$) [10].

The results of an experimental study, which compared virtual reality-based exercise to standard proprioceptive training, showed significant proprioception and neck pain improvement in both groups, with the virtual reality intervention showing more significant improvements ($p < 0.05$) [7]. The results suggest that sensorimotor retraining is an efficient program to improve cervical proprioception and postural stability in FHP.

Secondary Outcomes: Pain, Function, and Strength

The interventions also had a positive effect on secondary outcomes like neck pain, functional disability, scapular alignment, and grip strength. Multimodal corrective programs involving the use of PCEs, SSEs and kinesiotaping led to a significant increase in scapular position, dominant hand grip strength besides CVA improvement ($p < 0.05$) [4]. Moreover, the application of proprioceptive and stabilization training interventions was linked to the decrease of neck pain and disability and to the increase of the neuromuscular control [10,7].

Overall Synthesis of Findings

Among the presented randomised and experimental research papers, corrective exercise interventions, cervical stabilisation exercises, and proprioceptive motor training showed a recurrence of craniovertebral angle, proprioception, balance, and functional outcomes in people with forward head posture (Table 3). Multimodal programs that combined strengthening, stabilization, proprioceptive retraining or sensory feedback proved to be effective than other single-modality or educational interventions. It is believed based on the evidence that the combination of sensorimotor training and structural corrective exercises provides the most holistic results of rehabilitation of forward head posture.

Table 3. Synthesis of Effects (PRISMA Narrative Summary)

Intervention Type	Effect on CVA	Effect on Proprioception	Effect on Pain/Function	Evidence Strength
Corrective exercise programs (stretching + strengthening)	Moderate to large improvement	Moderate improvement	Reduced disability/pain	High
Cervical stabilization exercises	Significant CVA improvement	Improved joint position sense	Functional improvement	High
Proprioceptive training	Small–moderate CVA changes	Large improvements in proprioception	Pain reduction	Moderate
Multimodal programs (exercise + KT + SSE)	Greatest CVA improvement	Improved scapular mechanics & strength	Functional enhancement	High
VR-based training	Limited CVA evidence	Strong proprioception gains	Significant pain reduction	Emerging
Visual feedback stabilization	Significant CVA improvement	Enhanced proprioceptive accuracy	Improved postural control	Moderate

Risk of Bias within Studies

The Cochrane RoB 2 framework risk of bias assessment revealed that the methodological quality was generally acceptable (Table 3). The majority of trials mentioned sufficient randomization protocols and objective benchmarks of outcomes resulting in low bias in the allocation and outcome fields. Nonetheless, other studies were moderate in terms of the lack of reporting of the blinding procedures or allocation concealment that is typical in the exercise-based interventions. In general, three of the studies were considered to have low risk of bias, and three had moderate risk mostly because of performance and reporting constraints.

Table 4. Risk of Bias Assessment through Cochrane ROB 2

Study	Randomization	Blinding	Sample Size Adequate	Overall Bias Risk
Elgendy 2024	Yes	Assessor blinded	Moderate	Low
Özalp 2025	Yes	Single-blind	Large	Low

Izquierdo 2016	Yes	Not clearly blinded	Small	Moderate
Giridharan 2025	Experimental	Not specified	Small	Moderate
Titcomb 2023	Yes	Not specified	Moderate	Low–Moderate
Goo 2024	Yes	Not specified	Small	Moderate

Discussion

To evaluate the effectiveness of proprioceptive motor training in improving craniovertebral angle (CVA) in young adults with forward head posture

The current synthesis reveals that the pure proprioceptive motor training, and the combination of corrective or stabilization exercises, causes a significant change in the craniovertebral angle (CVA), i.e. the improvement of the head, neck alignment. In the randomized trials included in the present study, the interventions that involved proprioceptive retraining and cervical stabilization or multimodal corrective therapy proven to be more efficient in providing better postural correction than single-modality interventions. An example is that combined postural correction exercises, scapular stabilization and kinesiopanning resulted in the most positive differences in CVA between people with forward head posture [4]. On the same note, the effect of inclusion of proprioception training with cervical stabilization exercises showed better increase in CVA and postural alignment than stabilization exercises.

The findings indicate that sensorimotor integration and neuromuscular control of cervical musculature are improved with the use of proprioceptive motor training and therefore, can correct postural malalignment. Mechanically, proprioceptive retraining enhances the sense of joint position and motor skill of deep cervical flexors that are essential in the maintenance of neutral head positioning. This is in line with previous research findings which indicated that specialized cervical training can be used to regain neuromuscular control and minimize dysfunctional muscle activation patterns that relate to the forward head posture [10]. Thus, it seems that proprioceptive motor training could help cause structural postural correction not only by strengthening, but also by providing improved sensorimotor regulation.

Nonetheless, there is a variation of the extent of CVA improvement in different studies based on the composition of the interventions. Programs that incorporated proprioceptive retraining with either strengthening, stretching or stabilization exercises realized the greatest postural improvement, but isolated proprioceptive programs only realized moderate improvements but of clinical significance. This means that the proprioceptive motor training exercise has the highest chances of success when incorporated into a broad rehabilitation model that will deal with the muscular and sensorimotor impairments.

To determine the effects of proprioceptive motor training on secondary outcomes (proprioception, balance, pain, and function)

The studies included in the article all reported that the proprioception, balance, and functional outcomes had shown improvements after the interventions of proprioceptive motor training. The use of training protocols that consisted of joint position sense retraining and sensorimotor exercises greatly reduced the error in joint position sense and increased dynamic balance in subjects with forward head posture [8]. Proprioception is especially important as disturbed cervical afferent stimulation, and loss of joint position sense are the major factors contributing to postural instability and chronic neck dysfunction.

Moreover, a number of studies have shown that changes in neck pain and disability rates were lower after proprioceptive or stabilization training, which was found to be similar between intervention groups despite the similarity in structural postural correction [10]. Such results confirm the hypothesis that the process of sensorimotor control enhancement can reduce the symptoms regardless of the changes in the structural alignment. It was also experimentally demonstrated that sensorimotor training using virtual reality resulted in more improvement in proprioception and pain than proprioceptive training using conventional methods, which could suggest that augmented feedback and immersive settings can be more effective in motor learning and rehabilitation [7].

On the whole, these findings substantiate that proprioceptive motor training is not only multi-dimensional in terms of correcting posture but also plays a role in advancing neuromuscular control, balance capabilities, and reduction of symptoms; of course, in people with forward head posture.

To compare the effectiveness of proprioceptive motor training with conventional corrective or stabilization interventions

The comparative results suggest that proprioceptive motor training is as effective, at least, as traditional corrective or stabilization interventions in the improvement of postural outcomes and functional outcomes. Proprioception training and cranio-cervical flexion training in a randomized clinical trial yielded similar improvements in neuromuscular control, pain and disability, which postulates that sensorimotor retraining can produce similar clinical effect as traditional strengthening-based training [10].

Nonetheless, direct comparative studies that involved combined interventions have shown that, on average, the combination of proprioceptive training with corrective or stabilization exercises will have the best outcomes. Indicatively, stabilization exercises with visual feedback or proprioceptive elements provided more improvements in CVA and proprioceptors than when the exercises were done without the aid [9]. Similarly, the use of corrective exercise program with strengthening and stretching exercises proved to be more effective in terms of postural correction than education based interventions, yet again, the importance of active rehabilitation programs [2].

Overall, these results propose that even though standard corrective exercises are considered to be effective, they are more effective when they are supplemented with proprioceptive motor training, as they tend to correct underlying sensorimotor deficits that cause forward head posture.

Clinical Implications and Practice Recommendations

The results of this review are relevant to the practice of clinical rehabilitation and physiotherapy. To begin with, the regular increases in the craniovertebral angle, proprioception, and balance point to the fact that proprioceptive motor training must be viewed as one of the central aspects of the forward head posture rehabilitation programs. Clinicians are advised to use exercises aimed at developing cervical joint position sense, deep cervical flexor activation, and gaze stabilization with an aim of improving sensorimotor control and postural position.

Second, it seems that multimodal intervention programs offer the most clinical advantage. Combination of proprioceptive retraining and strengthening, stretching and stabilization exercises are recommended as rehabilitation protocols to manage the muscular imbalance as well as sensorimotor dysfunction. Specifically, scapular stabilization and cervical stabilization exercises could be integrated to improve functional outcomes because they would stimulate the cervical and shoulder girdle to coordinate their activity.

Third, augmented feedback methods, including visual feedbacks or training systems based on virtual reality could also be useful in order to improve the effectiveness of the rehabilitation. Motor learning can be aided using these technologies to give real-time postural awareness and enhance proprioceptive accuracy. Thus, practitioners in technologically furnished rehabilitation facilities are invited to take into account the use of feedback-based training modalities when dealing with patients with persistent postural dysfunction.

Lastly, rehabilitation interventions must be tailored according to patient characteristics, onset of forward head posture and the occurrence of other related symptoms like pain or lack of balance. The prescription of progressive exercises and adherence testing are needed to obtain prolonged posture and functional changes.

Conclusion

Finally, the current synthesis offers strong reasons to support the fact that proprioceptive motor training can be considered a strong and clinically significant intervention to enhance craniovertebral angle, sensorimotor control, balance, and functional outcomes in individuals with forward head posture. Although traditional corrective and stabilization exercises are still useful, the combination of the proprioceptive retraining has always produced better or complementary results because it directly addressed the sensorimotor deficits underlying the causes of postural dysfunction. The programs of multimodal rehabilitation that encompassed proprioceptive exercises along with strengthening, stretching, and stabilization and feedback-based training have shown the most significant improvements, and the comprehensive, neuromuscular-oriented approach to the postural correction is necessary. Taken together, these results indicate that proprioceptive motor training should be included into the list of evidence-based rehabilitation strategies to treat forward head posture, and can possibly improve both structural correction and functional restoration. Additional investigations in the form of future high-quality trials, using standardized methodologies and long-term follow-up to define the optimal dose of interventions, their sustainability of benefits, and their application to a wide range of clinical populations are warranted.

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