Neck Pain Management: Current Trends, Future Directions, And Research Priorities

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Abstract
Neck pain is a prevalent and burdensome health condition that significantly impacts individuals' well-being and productivity. This review paper aims to present a comprehensive overview of neck pain management, encompassing diverse aspects ranging from its anatomical and biomechanical foundations to emerging and complementary therapeutic approaches. The review explores the anatomy and mechanisms of neck pain, including the identification of common causes and classifications based on duration, severity, and etiology. Furthermore, it emphasizes the use of clinical evaluation methods in accurately assessing the condition. Non-pharmacological management approaches are meticulously examined, encompassing physical therapy, manual techniques and posture corrections. Pharmacological interventions, including over-the-counter analgesics, muscle relaxants, and prescription medications, are also critically reviewed, with special considerations for specific populations. Interventional and surgical options are explored, presenting the efficacy, risks, and limitations of these treatment modalities. Additionally, emerging therapies such as virtual reality, mind-body interventions and chiropractic care are discussed, alongside the significance of multidisciplinary care and collaborative efforts. The review concludes by identifying future research directions and addressing current gaps in the literature. The significance of continuous research and collaborative endeavors in advancing neck pain management is highlighted. Overall, this review serves as a valuable resource for healthcare professionals, researchers, and practitioners, aiming to improve the understanding and treatment of neck pain.

Keywords: Neck pain; Spinal manipulation; Physical therapy; Populations; Posture

1. Introduction

Neck pain emerges as a multifaceted ailment, presenting a significant challenge within contemporary society. While it may not be the most prevalent musculoskeletal disorder, neck pain's significance remains noteworthy [1,2]. The economic impact of neck pain is substantial, encompassing expenses related to treatment, diminished productivity, and work-related issues. Notably, in 2016, among 154 conditions, low back and neck pain accounted for the highest healthcare expenditure in the United States, reaching an approximate sum of $134.5 billion. Correspondingly, during 2012, neck pain led to work absences for 25.5 million Americans, resulting in an average of 11.4 days away from their occupations [3]. Additionally, in 2017, the worldwide age-standardized prevalence and incidence rates for neck pain were recorded at 3551.1 and 806.6 per 100,000 individuals, respectively [4].

The prevalence of neck pain exhibited a greater burden among females compared to males. Specifically, in the year 2017, the reported instances of neck pain for females stood at 166.0 million (with a confidence interval of 118.7 to 224.8), while for males, the figure was 122.7 million (with a confidence interval of 87.1 to 167.5). Furthermore, the cumulative years lived with disability (YLDs) attributed to neck pain were higher for females, totaling 16.4 million (with a confidence interval of 10.0 to 25.1), as opposed to 12.2 million (with a confidence interval of 7.4 to 18.9) for males. On a global scale, the age-standardized prevalence of neck pain experienced an upward trend in correlation with age, peaking within the 70–74 age bracket, and subsequently declining as age advanced. Notably, the pattern of YLDs across different age groups closely mirrored that of the estimated point prevalence [4].

Several studies have explored the correlation between neck pain and its corresponding factors. Notably, research conducted in China revealed that individuals who reported experiencing neck pain were those engaging in manual activities above shoulder level, utilizing vibrating tools, and maintaining a seated or

standing posture with their necks bent [5]. Similarly, within the United States, neck pain exhibited associations with certain demographics and health conditions. It was linked to women, individuals who were married or separated, and those dealing with various morbidities such as respiratory, cardiovascular, and gastrointestinal diseases, alongside psychological manifestations like depression, sleep difficulties, and insomnia. Conversely, a higher educational level and regular engagement in physical activities were identified as protective factors against neck pain [6,7].

Neck pain stands as a prominent source of both morbidity and disability, exerting its influence on daily life and occupational settings across various nations. This condition possesses the potential to impact an individual's physical, social, and psychological well-being, consequently contributing to escalated societal expenses and disruptions within the business realm. Additionally, as the aging population expands within medium- and low-income countries, the prevalence of neck pain is anticipated to surge notably in the forthcoming decades. This emphasizes the necessity for an understanding of the associated risk factors and approaches to prevention and treatment. Such interventions may encompass techniques like global postural re-education, segmental stretching, dry needling, and percutaneous electrical nerve stimulation, among others [8–10].

The purpose of this review paper is to comprehensively explore the management of neck pain, a prevalent health issue with significant implications for individuals' well-being and productivity. Through a systematic examination of various aspects, including the anatomical and biomechanical underpinnings of neck pain, classification and assessment methods, non-pharmacological and pharmacological management approaches, interventional and surgical options, emerging and complementary therapies, and prevention strategies, this paper aims to provide a thorough understanding of the current state of neck pain management. Additionally, the review will identify existing research gaps and future directions, emphasizing the importance of ongoing collaboration and research efforts to optimize patient outcomes and enhance the quality of care provided to individuals with neck pain.

2. Anatomy and Mechanisms of Neck Pain

2.1 Anatomy of the neck region

The term "neck" refers to the complex assembly of structures that establish a connection between the head and the torso. This complex framework encompasses an array of elements, including bones, muscles, nerves, blood vessels, lymphatics, and various other connective tissues. The cervical spine constitutes the osseous component of the neck, serving as its foundational structure. Its principal role entails offering support to the skull while permitting a range of motion. Remarkably supple, the cervical spine represents the most adaptable segment of the spine, facilitating expansive movements crucial for surveying our environment. Given that a majority of sensory inputs originate from the head, ensuring proper neck mobility emerges as imperative for survival. Furthermore, the neck assumes the role of a conduit, facilitating communication between the brain and the body. The transfer of motor and sensory information, as well as essential nutrients, occurs bidirectionally through the neck—linking the body to the head and vice versa. The neck, however, remains susceptible to strain and is vulnerable to injuries. Considering its significance, injuries sustained in this region can yield substantial repercussions for our bodily functions, occasionally culminating in fatality [11].

The cervical spine, comprising seven vertebrae, includes the distinctive C1 and C2 vertebrae, recognized as "atypical" due to their specialized bony structures tailored to support and facilitate skull movement. Despite the cervical spine's capacity for flexion, extension, rotation, and lateral bending, each individual joint within the cervical region exhibits a primary motion. C1, designated as the atlas, lacks a spinous process and establishes articulation with the occipital condyles of the skull's occiput bone, shaping the occipital-atlanto (OA) joint. This joint serves as a nexus between the skull and the neck, affording attachment sites for specific neck muscles and providing support to bear the weight of the skull. Its core motions encompass flexion and extension. Conversely, C2, known as the axis, forms a superior articulation with C1 through a distinctive bony projection termed the dens or odontoid process. The dens projects upwards from the vertebral body and engages with the atlas. Notably, the dens enable pivotal movement, considerably expanding the scope for lateral head rotation. Progressing to vertebrae C3 through C7, classified as "typical" cervical vertebrae, the upper portion of the lower cervical unit (C2-C4) primarily engages in rotation, while the lower portion specializes in lateral bending. The delineation of spinal and vertebral motions is oriented in relation to their anterior and superior surfaces [12].

The distinct motions of the cervical spine includes:

- Cervical flexion involves tilting the head forward towards the chest.
- Cervical extension encompasses tilting the head backward with the face oriented towards the sky.
- Cervical rotation entails turning the head to the left or the right.
- Cervical side-bending entails inclining the head to the side or bringing an ear closer to the corresponding shoulder.

The primary role of the cervical spine lies in the stabilization and maintenance of the head, positioning it to ensure our eyes remain parallel to the ground. This alignment is of paramount importance for our vestibular

function, which plays a pivotal role in maintaining balance. Beyond this fundamental task, the cervical spine also facilitates extensive movements, pivotal for surveying our environment and accommodating interactions with it. Moreover, the cervical spine contributes to multiple vital functions. It participates in the swallowing process and aids in the elevation of the rib cage during inhalation, aiding in the mechanics of breathing. Notably, the vertebral bodies of the cervical spine serve as protective shields for both the spinal cord and vertebral arteries. Additionally, the neck's complex muscular framework safeguards other neurovascular structures essential for sustaining life. The interplay of these functions highlights the critical nature of uninterrupted neck function. Any disruption to this functionality can precipitate a precarious state, thus highlighting why the assessment of neck function typically takes precedence in emergency evaluations [13].

2.2 Biomechanics and functions of the cervical spine

Understanding the biomechanics of the cervical spine is of paramount importance when delving into the mechanisms underlying neck pain, forming a foundational element within this comprehensive review. Comprising seven vertebrae denoted as C1-C7, the cervical spine is a dynamically mobile and flexible region tasked with supporting the head's weight and facilitating its diverse array of movements. This distinctive anatomy and function render the cervical spine susceptible to an array of stresses, which can potentially trigger sources of discomfort. Interconnecting the cervical vertebrae are vital components such as intervertebral discs, facet joints, ligaments, and muscles, together orchestrating a delicate balance between stability and mobility. Intervertebral discs, akin to shock absorbers, assume the critical role of facilitating fluid motions and distributing mechanical loads uniformly within the spine. Situated at the posterior aspect of the vertebrae, the facet joints not only foster articulation but also guide the motion sequences of the cervical spine. The biomechanics intrinsic to the cervical spine confer a remarkable range of movements, encompassing flexion, extension, lateral bending, and rotation. Alas, it is worth noting that a significant portion of neck pain instances can be traced back to mechanical factors. These factors, ranging from compromised posture and repetitive movements to overuse injuries, impose strains on the cervical structures, ultimately culminating in discomfort and functional disturbances [14].

A comprehensive understanding of the craniovertebral junction (C0–C1), the upper cervical spine (C1–C2), and the lower cervical spine (C3–C7) requires a separate delineation of their distinctive anatomical and kinematic attributes. Crucial to grasping the cervical spine's behavior is recognizing how each segment contributes to the overall function in alignment with its specific traits. Employing a descriptive framework, the cervical spine can be partitioned into five units, each characterized by unique morphology that governs its kinematics and the proportion it contributes to the comprehensive function. In anatomical terms, these units encompass the occipito-cervical junction (C0–C1), the atlas (C1), the axis (C2), the C2–C3 junction, and the C3–C7 levels. When juxtaposing the upper and lower cervical spine's anatomical characteristics, noteworthy differences come to light. These disparities encompass the absence of the intervertebral disc in the upper cervical region, the lack of the ligamentum flavum, and the distinct structural variances observed between the C1 and C2 vertebrae. Understanding these nuanced distinctions is pivotal in grasping the mechanics of the cervical spine and how each component harmoniously contributes to the overall functionality of this vital anatomical region [14,15].

2.3 Common causes and mechanisms of neck pain

Neck pain can arise from a variety of factors including arthritis, disc degeneration, spinal canal narrowing, muscular inflammation, strain, or trauma. In rare instances, it could serve as an indicator of cancer or meningitis. When dealing with severe neck issues, it is advisable to consult a primary care physician, and often, a specialist such as a neurosurgeon, for precise diagnosis and suitable treatment recommendations [16].

Conditions such as aging, injuries, incorrect posture, or ailments like arthritis can trigger the degeneration of cervical spine bones or joints, subsequently leading to the formation of disc herniation or bone spurs. Sudden and intense neck injuries can also contribute to complications such as disc herniation, whiplash, damage to blood vessels, vertebral injury, and in severe instances, even result in lasting paralysis. Herniated discs or bone spurs might lead to the narrowing of the spinal canal or the small openings through which spinal nerve roots emerge, exerting pressure on the spinal cord or nerves [17].

The imposition of pressure on the cervical spinal cord presents a significant concern due to the fact that nearly all nerves responsible for innervating various body regions must traverse through the neck to reach their intended destinations (such as arms, chest, abdomen, legs). This has the potential to impede the function of vital organs. Nerve pressure can give rise to sensations of numbness, pain, or weakness in the corresponding arm area that the nerve serves. [18].

The mechanisms of neck pain are multifaceted, involving a complex interplay of anatomical, biomechanical, neurological, and psychosocial factors. Understanding these mechanisms is essential for accurate diagnosis, targeted management, and the development of effective treatment strategies. Several key mechanisms contribute to the occurrence and persistence of neck pain:

Musculoskeletal Strain: One of the most common causes of neck pain is musculoskeletal strain, often resulting from poor posture, prolonged static positions, repetitive movements, or sudden overexertion. Such strain can lead to muscle imbalances, tension, and microtrauma, causing discomfort and pain [19].

Cervical Spine Pathology: Various cervical spine pathologies, such as degenerative disc disease, osteoarthritis, herniated discs, and spinal stenosis, can result in nerve compression and inflammation, leading to neck pain and potential referral of pain into the shoulders and arms [20].

Radicular Pain: Compression or irritation of cervical nerve roots can lead to radicular pain, characterized by pain, tingling, or numbness radiating down the arm, resulting in conditions like cervical radiculopathy [21].
Myofascial Pain Syndrome: Myofascial trigger points, which are hyperirritable spots in muscles, can refer pain to the neck region, causing myofascial pain syndrome [22].

Central Sensitization: Prolonged pain can lead to central sensitization, a phenomenon in which the central nervous system becomes hypersensitive to pain signals. This amplifies pain perception and can contribute to the chronicity of neck pain [23].

Postural and Ergonomic Factors: Poor posture and improper ergonomics, especially in sedentary work environments, can place undue stress on the neck structures, leading to pain and discomfort [24,25].

Whiplash Injury: Sudden acceleration-deceleration forces, typically occurring in motor vehicle accidents, can result in whiplash injury, causing neck pain and other associated symptoms [26].

3. Classification and Assessment of Neck Pain

Accurate characterization and effective management of neck pain hinge upon its classification. The Neck Pain Task Force has introduced a robust classification system, integrating multiple facets of neck pain to augment clinical comprehension and direct treatment strategies. This encompassing system incorporates five axes, of which two address contextual factors, while the remaining three investigate into the intrinsic nature of the neck pain itself [27].

Regarding its contextual aspects, the classification system comprehensively factors in severity, duration, and pattern when assessing neck pain. The classification system employs four distinct categories to gauge severity, taking into account both the intensity of symptoms and their impact on daily functioning. Grade I correspond to low disability and intensity, while grade II signifies low disability with heightened symptom intensity. Grade III encompasses high disability alongside moderate limitations, and grade IV pertains to high disability coupled with severe limitations. Duration, constituting another contextual axis, serves to differentiate neck pain based on its temporal characteristics. This classification categorizes neck pain as transitory, representing a brief episode, or as either short duration or long duration, considering the persistence of symptoms over varying time spans. Furthermore, the pattern axis contributes to the classification by elucidating the occurrence patterns of neck pain. This axis classifies neck pain as a single episode, recurrent in nature, or persistent. By acknowledging the diverse temporal patterns that neck pain can adopt, this aspect enriches our understanding of the condition's nuances. It's worth noting, however, that the Neck Pain Task Force's classification system, while comprehensive in assessing severity, duration, and pattern, lacks the incorporation of qualitative methodologies. This omission overlooks the qualitative nature of pain experiences as a defining component of the taxonomy. Qualitative facets of pain, encompassing descriptors, sensory attributes, and quality, offer valuable insights into underlying mechanisms, potentially guiding tailored interventions [28].

The evaluation of neck pain holds significant importance in comprehending and effectively addressing neck-related disorders. Historically, the assessment of pain among individuals with neck disorders has primarily revolved around quantifying pain intensity as a fundamental outcome measure. Nevertheless, recent findings, particularly within the domain of traumatic neck pain, illuminate the substantial influence of pain quality. This aspect not only influences prognosis but also shapes treatment strategies and response patterns. This emerging insight accentuates the necessity for an all-encompassing evaluation framework for neck pain, encompassing both quantitative and qualitative dimensions [29].

Recognizing the multifaceted essence of neck pain, the Neck Pain Task Force has advocated for a paradigm shift those entails incorporating both quantitative methods and qualitative approaches in forthcoming research initiatives [28]. While quantitative methods traditionally aim to test hypotheses and measure objective variables, qualitative methodologies seek to offer a more nuanced comprehension of phenomena, providing insights into subjective experiences and perspectives. The use of qualitative approaches in assessing neck pain extends beyond mere hypothesis testing; rather, it explores into capturing a comprehensive and profound portrayal of the complex facets of neck pain experiences. This approach holds the potential to illuminate dimensions of

pain that quantitative methods might inadvertently overlook. Qualitative methodologies uncover personal narratives, emotional subtleties, and sensory attributes tied to neck pain. By doing so, they contribute to a more holistic and individual-centered comprehension of the condition. This enriched understanding can carry practical implications for clinical practice. It assists in identifying relevant outcome measures that aptly encompass the diverse dimensions of neck pain. Moreover, insights gleaned from qualitative assessments can steer the development of targeted interventions, aligning treatments more effectively with individual needs and experiences [28].

4. Non-Pharmacological Management Approaches

Advantages and Disadvantages of various non-pharmacological management approaches for neck pain management is summarized in Table 1.

4.1 Physical therapy

Physical therapy stands as one of the most prevalent treatments for chronic neck pain. The typical approach to physical therapy for neck pain involves applying interventions aimed at alleviating pain and/or stiffness, creating a foundation for initiating an exercise regimen that focuses on strengthening and stretching the neck. The precise techniques and exercises incorporated in physical therapy, as well as the duration of the treatment plan, can differ from person to person. Even in cases where complete pain elimination isn't achieved, physical therapy holds a vital role in enhancing neck posture and functionality for daily activities [30]. Physical therapy for neck-related concerns is recommended across various scenarios, including:

- When neck pain persists or recurs without a clearly identifiable source or mechanism. In instances where a diagnosis remains elusive, bolstering the strength of the neck's muscles can enhance their capacity to support the cervical spine and build resilience against pain.
- Injuries like whiplash, which can cause damage to the neck's soft tissues and joints, leading to persistent pain and stiffness. A well-designed physical therapy program can mitigate pain and facilitate a return to normal neck function.
- Following neck surgeries that result in notable pain and stiffness during the postoperative weeks and months. For instance, surgeries like anterior cervical discectomy with fusion (ACDF) involve the fusion of cervical vertebrae, altering the movement of certain neck and upper back muscles. In these instances, physical therapy serves to address stiffness, enhance neck functionality, and diminish or forestall painful spasms as the muscles undergo reconditioning [31].

In addition to the previously mentioned scenarios, physical therapy for neck-related concerns might also be advised as a component of broader treatment programs for other illnesses or chronic conditions. The existing medical literature emphasizes the value of physical therapy, backed by moderate to strong evidence, in its capacity to alleviate neck pain and enhance the range of motion. This collective body of knowledge emphasizes the positive impact that physical therapy can bring about, extending beyond isolated neck issues and encompassing a spectrum of medical contexts [32–34].

4.2 Manual therapy techniques

Given the broad spectrum of interventions encompassed by manual therapy (MT), a systematic review opted for the utilization of a clinical sub-classification system to categorize MT techniques. This sub-classification system consists of four primary categories, aiming to provide a structured framework for organizing and evaluating the diverse range of MT interventions [35]. Furthermore, the adoption of this sub-classification was aligned with a comprehensive evidence-based search strategy, as well as the manual therapy treatments applied and documented within the intervention group (IG) of the included randomized controlled trials (RCTs). This approach ensured consistency between the sub-classification system and the empirical data collected from the selected studies.

MT1 entails spinal manipulation, which involves the application of a high-velocity, low-amplitude (HVLA) thrust with the intention of inducing a characteristic "cavitation" effect. This technique is specifically directed at the cervical spine (Cx) or thoracic spine (Tx) [36–38]. MT2 encompasses a spectrum of mobilization techniques directed at the cervical spine (Cx) or thoracic spine (Tx). These techniques encompass low-velocity mobilization methods, including physiological or accessory mobilization, as well as articular muscle-energy techniques (MET) such as segmental analytic myotensive mobilization of Cx and Tx. Additionally, soft-tissue techniques (STT) like "myofascial release," "trigger points," and "muscular MET" (involving analytical myotensive techniques on specific muscles utilizing "contract-relax" neurophysiological principles) within the neck region are included in this category. MT3 involves the integration of MT2 and MT1 techniques, forming a combined approach to treatment. MT4 corresponds to mobilization-with-movement (MWM) interventions featuring cervical sustained natural apophyseal glides (SNAGs) developed by Mulligan [39].

Additionally, in acknowledgment of contemporary manual therapy's inclusion of hands-off approaches, the sub-categorization of groups MT1-4 was determined based on the presence or absence of exercise integration.

This encompassed both specific exercises, such as those grounded in directional preference, as well as activities aimed at strengthening and stabilizing particular deep-neck and scapular muscles, along with exercises targeting motor control. Furthermore, more general exercises, like range of motion exercises for the head and neck or corrections in sitting posture, were also considered. Lastly, usual medical care (UMC) was also considered as a component, involving face-to-face interviews, educational components, reassurance, medication, ergonomic recommendations, and advice for maintaining an active lifestyle [35,37,39–41].

A recent study has not only reaffirmed prior evidence but also bolstered confidence in the effectiveness of manual techniques for treating neck pain (NP). The clinical implications of this study can be distilled into several key points. Firstly, it is apparent that combining various forms of manual therapy (MT) with exercise yields superior results compared to either MT or exercise in isolation. Secondly, a body of moderate to strong evidence indicates the efficacy of MT1 or MT3, combined with exercise, in enhancing pain relief, functional improvement, and patient satisfaction among individuals with NP. This favorable outcome holds true when comparing these combined approaches to usual medical care (UMC), exercise alone, MT alone, or no treatment. Thirdly, robust evidence suggests that for chronic NP, mobilization need not necessarily be directed at the symptomatic level to achieve pain alleviation and enhanced function. This finding bears significance in terms of mitigating the risks associated with certain MT techniques applied to the cervical spine (Cx), while also emphasizing the importance of choosing the appropriate level(s) of Cx treatment based on the patient's sensitivity to treatment. Fourthly, moderate evidence indicates that MT1, MT2, and MT4 generally yield comparable effects on NP. Given that cervical manipulation carries a higher risk compared to mobilization or mobilization with movement (MWM), these interventions could be regarded as viable alternatives for NP management, particularly when combined with exercise and MT1 targeting the thoracic region. In planning future randomized controlled trials (RCTs), it is imperative to ensure a more rigorous approach by avoiding the amalgamation of patient categories and intervention types. This refinement in study design will contribute to more accurate and insightful investigations into the efficacy of various treatment modalities for NP [39].

4.3 Posture correction and ergonomic interventions

Effectively managing neck pain often requires a comprehensive approach, and within the array of strategies employed, the correction of posture and implementation of ergonomic interventions have gained prominence for their potential to alleviate discomfort and enhance long-term well-being. Particularly in settings involving desk-based work, where individuals spend extended periods engaged in computer-related tasks, the integration of office ergonomics training and therapeutic exercises has emerged as a promising avenue. This approach aims to improve workstation behaviors, mitigate musculoskeletal risks, and alleviate strain for healthcare professionals and other desk-job occupants [42].

Office ergonomics training targets the optimal arrangement of essential elements within the workspace, including monitors, keyboards, elbows, forearms, upper arms, wrists, shoulders, lumbar support, thighs, knees, and feet. By optimizing these elements, ergonomic interventions strive to reduce strains and undue pressures on the neck and upper body. A randomized trial conducted over a six-month period highlighted the effectiveness of combining exercise with ergonomic adjustments, or exercise alone, in reducing the severity of neck pain experienced by desk-based workers. The favorable outcomes of this study underline the potential positive influence of a well-designed ergonomic setup in alleviating discomfort and enhancing overall well-being [43].

Therapeutic exercises assume a pivotal role in the management of neck pain, especially for individuals grappling with persistent discomfort, compromised posture, and associated health issues. These exercises, targeting the control, strength, and coordination of neck muscles, encompass a spectrum of activities including strengthening exercises and progressive resistance training. A significant focus is placed on cultivating coordination between the neck and shoulders while also safeguarding the strength of the shoulder girdle. Of paramount importance is the incorporation of proper posture during exercises, a critical factor in the enduring retraining of muscle control and the overall efficacy of therapeutic exercises [44,45].

Supporting this approach, research conducted by Mahmud et al. reinforces the advantages of ergonomic adjustments within workplace settings. Their randomized controlled trial demonstrated that altering workplace habits resulted in improved body postures and enhanced computing skills among workers, potentially reducing the risk of future musculoskeletal issues. Over time, participants who underwent ergonomic training reported a decrease in occurrences of discomfort in the neck, upper back, and lower back regions. This study highlights the potential of ergonomic interventions in promoting both immediate and long-term well-being among individuals facing the challenges of desk-based work [46].

Another study with a specific focus on office ergonomics intervention yielded notable results. In this study, individuals who received training in both chair ergonomics and office ergonomics reported reduced pain and discomfort throughout their workday, in contrast to those who received training in one aspect alone or were part of a control group. This outcome emphasizes the tangible benefits of comprehensive ergonomic training in creating a more comfortable and pain-free work environment for individuals engaged in desk-based tasks [47].

The synergistic implementation of therapeutic exercises and ergonomic training leads to significant outcomes. This integrated approach results in the reduction of pain, improved posture, and decreased levels of disability. Notably, it exhibits superior efficacy in addressing neck pain when compared to the use of individual strategies in isolation. The fusion of ergonomic principles with tailored exercises yields substantial benefits, including enhanced strength, improved functionality, better health-related quality of life, and reduced pain ratings. This combined approach showcases the potential for comprehensive interventions to produce comprehensive and positive effects on individuals dealing with neck pain [48].

4.4 Acupuncture and dry needling

A study looked at how using dry needling on sore points in the muscles (myofascial trigger points) can help reduce pain. People who had shoulder or neck pain for more than three months and had these sore points took part. They got three sessions of dry needling treatment every week. They measured the pain before and after the treatment using a scale and other methods. Out of 52 people, 41 saw the sore points change from active to not as active or gone, while 11 didn't see a change. All types of pain went down a lot. They also checked other things like mood, how well they can move their neck, and how much their pain affects their life. The sore points didn't change much, but people felt better, could do more, and their mood improved. So, the study found that using dry needling can really help reduce pain and improve how people feel and function [49].

A study looked at whether deep dry needling (DDN) of sore muscle points could help treat ongoing neck pain. They randomly divided 128 people with neck pain and sore points in their neck muscles into two groups. One group got DDN along with gentle stretching, and the other group only did stretching. Each group got four treatments over two weeks and were checked again after six months. Some people felt sore and had a little bleeding where the needles were inserted, but it went away in about a week. The study found that the group that got DDN had less pain, improved ability to move their neck, more strength, and felt less disabled compared to the stretching-only group [50]

A clinical trial (with the registration number NCT02301468) investigated the effects of dry needling (DN) and manual pressure (MP) treatments on myofascial pain in women. The study involved 42 female patients who were split into two groups: one group received four sessions of DN, and the other received MP treatments. One person from the MP group and three from the DN group dropped out. Some people reported feeling sore after the dry needling treatment. The study did not show significant differences between the two groups when it came to measures like the pain pressure threshold (PPT), muscle characteristics before and after treatment, the neck disability index (NDI), and the pain rating on a scale (NRS). However, three months after the treatments, both groups experienced significant improvements in the NDI, NRS, PPT, muscle elasticity, and stiffness [51].

A systematic review examined the effectiveness, potential harm, and cost-effectiveness of complementary and alternative medicine (CAM) therapies for treating back, neck, and thoracic pain. They analyzed 265 randomized controlled trials (RCTs) and 5 non-randomized controlled trials (non-RCTs) related to therapies like acupuncture, massage, spinal manipulation, and mobilization. In acupuncture, common adverse events included minor bleeding, bruising, soreness, pain at the needle site, dizziness, lightheadedness, and headaches. The percentage of people experiencing adverse events was similar to those receiving conventional care or transcutaneous electrical nerve stimulation (TENS). For chronic non-specific low back pain, acupuncture showed a significant reduction in pain intensity compared to placebo, but only right after treatment. There was no difference between acupuncture and placebo in terms of pain medication intake, overall improvement in low back pain, or post-treatment disability. Regarding chronic non-specific neck pain, acupuncture and sham-acupuncture had similar immediate post-treatment effects on pain reduction. Compared to no treatment, acupuncture improved pain intensity, disability, functioning, well-being, and range of motion immediately after treatment. Studies using sham-acupuncture were more likely to have insignificant results compared to studies using placebos like laser therapy or medications. Results were less consistent when acupuncture was compared to other treatments like mobilization. In terms of cost-effectiveness, acupuncture was found to be more economical than conventional treatment or no treatment for chronic back pain. Overall, the review suggests that acupuncture can provide short-term pain relief for chronic back and neck pain, but its long-term effectiveness and consistency can vary based on comparison methods and the specific condition being treated [52].

In a comprehensive study, researchers conducted a systematic review and meta-analysis of fourteen randomized controlled trials (RCTs) focusing on the effectiveness of acupuncture for neck pain. Within this review, nine meta-analyses were conducted, and seven of them revealed positive outcomes. The primary focus of the study was on short-term pain reduction, which was the main outcome measured. The analysis demonstrated that acupuncture was more effective in alleviating neck pain when compared to control groups. Furthermore, the findings indicated that acupuncture had a superior impact on pain relief compared to sham acupuncture. Additional encouraging results included improvements in neck range of motion (ROM), the management of cervical radiculopathy, and pain control. These positive effects were observed in comparison

to both sham acupuncture and no treatment. Collectively, this systematic review and meta-analysis provide strong evidence supporting the efficacy of acupuncture as a treatment option for neck pain. The results highlight the potential benefits of acupuncture in terms of reducing pain, enhancing neck mobility, addressing cervical radiculopathy, and managing discomfort, particularly when compared to sham treatments or no intervention [53].

A study investigated the effectiveness of acupuncture using seven acupoint-penetrating needles for patients with cervical spondylosis. The participants were randomly divided into two groups: one received acupuncture with the specific needles along with traction, while the other received acupuncture using non-relevant acupuncture points along with traction. The study assessed both groups in terms of effectiveness and changes in scores on the Visual Analogue Scale (VAS) for pain, the Neck Disability Index (NDI), and the Pittsburgh Sleep Quality Index (PSQI). Results showed that the group receiving specific acupuncture had a higher overall effectiveness rate compared to the other group. Both groups saw a significant decrease in scores for VAS, NDI, and PSQI after the treatment compared to before. The group receiving specific acupuncture had notably lower NDI and PSQI scores after treatment compared to the other group. The study concluded that among patients with cervical spondylosis, acupuncture using specific acupoint-penetrating needles along with traction demonstrated greater effectiveness, reduced pain, and improved sleep quality compared to acupuncture using non-relevant acupuncture points. [54]. Both acupuncture and dry needling have demonstrated their effectiveness in providing relief from pain, both immediately after treatment and over the long term. These therapeutic approaches are generally safe and cost-effective. Therefore, they should be considered as valuable components within a comprehensive approach for managing neck pain.

4.5 Cognitive-behavioral therapy

Cognitive Behavioral Therapy (CBT) is a widely used psychological treatment for chronic pain conditions. CBT aims to modify unhelpful thought patterns and enhance mood, leading to gradual changes in thinking and behavior related to illness. In the context of neck pain, a recent Cochrane review, while noting that the available evidence was of varying quality, found CBT to be more effective in reducing short-term pain and disability when compared to no treatment. This review highlighted that the evidence was moderate in quality for specific outcomes, such as decreasing kinesiophobia in the intermediate term. For subacute neck pain, CBT showed effectiveness in reducing pain in the short term compared to other treatments, but did not significantly affect disability or kinesiophobia. In broader terms, a study by Shearer and colleagues did not provide clear evidence either supporting or refuting the use of psychological interventions, including relaxation training and CBT, for patients with recent onset neck pain or whiplash-associated disorder. Overall, CBT holds promise as an approach to address psychological aspects of neck pain, with varying levels of evidence supporting its effectiveness in different contexts [55]. For chronic neck pain, researchers found evidence that a progressive goal attainment program may be helpful.

Table 1. Advantages and Disadvantages of various non-pharmacological management approaches for neck pain management

Approach	Advantages	Disadvantages
Physical therapy	- Improves posture, flexibility, strength, balance, and relaxation - Reduces pain, stiffness, disability, and recurrence - Enhances self-management and coping skills	- Requires time, effort, and motivation from the patient - May cause temporary soreness or discomfort - May have limited availability or accessibility for some patients
Manual therapy techniques	- Relieves pain, stiffness, muscle spasm, and nerve compression - Restores normal motion and function of the spine - Provides immediate and lasting effects	- May cause adverse effects such as bleeding, infection, nerve damage, spinal cord injury, or allergic reaction - May have variable efficacy depending on the technique, accuracy, volume, concentration, and frequency of the interventions - May not address the underlying cause of neck pain
Posture correction and ergonomic interventions	- Prevents or reduces muscle strain, fatigue, and tension - Improves spinal alignment and stability	- Requires awareness, education, and feedback from the patient or a professional

	- Reduces the risk of injury or recurrence	- May involve changing habits or modifying the work or home environment - May have limited evidence or applicability for some interventions
Acupuncture and dry needling	- Provides analgesia and reduces inflammation by stimulating endogenous opioids, serotonin, and other neurochemicals - Modulates pain perception and processing by activating descending inhibitory pathways - Has minimal adverse effects when performed by a trained practitioner	- May have variable efficacy depending on the technique, location, depth, duration, and frequency of needle insertion - May cause bleeding, infection, nerve damage, or pneumothorax if performed incorrectly - May have limited availability or acceptability for some patients due to needle phobia or cultural beliefs
Cognitive-behavioral therapy	- Reduces stress, anxiety, depression, and negative emotions that may contribute to neck pain - Improves coping skills, self-efficacy, and pain acceptance - Enhances function and quality of life	- Requires time, effort, and motivation from the patient - May involve confronting negative thoughts or emotions that may be uncomfortable - May have limited availability or accessibility for some patients due to cost or stigma

5. Pharmacological Management Approaches

Neck pain is a common condition that can affect the quality of life and function of individuals. There are various pharmacological options available for the management of neck pain, depending on the cause, severity, and duration of the pain, as well as the patient's preferences, comorbidities, and potential drug interactions [56]. The following is a brief overview of some of the pharmacological management approaches for neck pain, with references to relevant sources.

5.1 Over-the-counter analgesics

Over-the-counter (OTC) analgesics are medications that can be purchased without a prescription and are commonly used for mild to moderate neck pain. They include acetaminophen (paracetamol), aspirin, ibuprofen, naproxen, and other nonsteroidal anti-inflammatory drugs (NSAIDs). These drugs work by reducing inflammation and blocking pain signals in the nervous system. They are generally safe and effective when used as directed, but they may have side effects such as gastrointestinal irritation, bleeding, ulcers, liver damage, kidney damage, or cardiovascular events. Therefore, they should be used with caution in patients with history of peptic ulcer disease, liver disease, kidney disease, heart disease, stroke, or bleeding disorders. They should also be avoided in patients who are allergic to any of the ingredients or who are taking other medications that may interact with them [57].

5.2 Muscle relaxants

Muscle relaxants are medications that act on the central nervous system to relax the skeletal muscles and reduce muscle spasms. They are often prescribed for acute neck pain associated with muscle strain or injury. They include cyclobenzaprine, carisoprodol, methocarbamol, baclofen, tizanidine, and others. These drugs can provide short-term relief of neck pain and improve range of motion, but they may also cause side effects such as drowsiness, dizziness, dry mouth, blurred vision, constipation, or urinary retention. Therefore, they should be used with caution in patients who have impaired driving or operating machinery skills, glaucoma, urinary retention, or who are taking other sedating medications. They should also be avoided in patients who have history of drug abuse or dependence [57,58].

5.3 Topical analgesics

Topical analgesics are medications that are applied directly to the skin over the painful area of the neck. They include creams, gels, patches, sprays, or ointments that contain ingredients such as menthol, camphor, capsaicin, lidocaine, diclofenac, or salicylates. These drugs work by stimulating or blocking nerve endings in the skin and reducing inflammation and pain perception. They are generally safe and effective when used as directed, but they may have side effects such as skin irritation, rash, burning sensation, allergic reaction, or systemic absorption. Therefore, they should be used with caution in patients who have sensitive skin or who

are allergic to any of the ingredients. They should also be avoided in patients who have open wounds or broken skin over the affected area [57,59].

5.4 Nonsteroidal anti-inflammatory drugs (NSAIDs)

NSAIDs are a class of medications that reduce inflammation and pain by inhibiting the enzyme cyclooxygenase (COX), which is involved in the synthesis of prostaglandins. Prostaglandins are chemical messengers that mediate inflammation and pain in response to tissue injury or infection. NSAIDs include OTC analgesics such as aspirin, ibuprofen, naproxen, and others, as well as prescription drugs such as celecoxib, diclofenac, etodolac, indomethacin, ketorolac, meloxicam, and others [60]. NSAIDs are effective for acute and chronic neck pain caused by various conditions such as osteoarthritis, rheumatoid arthritis, ankylosing spondylitis, cervical spondylosis, or whiplash injury. They can also reduce fever and swelling associated with neck pain. However, NSAIDs may have side effects such as gastrointestinal irritation, bleeding, ulcers, liver damage, kidney damage, or cardiovascular events. Therefore, they should be used with caution in patients with history of peptic ulcer disease, liver disease, kidney disease, heart disease, stroke, or bleeding disorders. They should also be avoided in patients who are allergic to any of the ingredients or who are taking other medications that may interact with them [57].

5.5 Prescription medications for neuropathic pain

Neuropathic pain is a type of chronic pain that results from damage or dysfunction of the nerves or the central nervous system. It is often described as burning, shooting, tingling, numbness, or electric shock-like sensations in the affected area. Neuropathic pain can occur in the neck due to various conditions such as cervical radiculopathy, cervical spondylotic myelopathy, postherpetic neuralgia, or complex regional pain syndrome [61]. Neuropathic pain is often difficult to treat and may require prescription medications that target specific mechanisms of pain transmission or modulation. These medications include antidepressants such as amitriptyline, duloxetine, venlafaxine, or nortriptyline; anticonvulsants such as gabapentin, pregabalin, carbamazepine, or lamotrigine; opioids such as tramadol, oxycodone, morphine, or fentanyl; and others such as lidocaine patches, capsaicin patches, or botulinum toxin injections. These drugs can provide moderate to substantial relief of neuropathic pain and improve function and quality of life, but they may also cause side effects such as sedation, dizziness, nausea, constipation, dry mouth, weight gain, or dependence [62,63]. Therefore, they should be used with caution in patients who have impaired driving or operating machinery skills, glaucoma, urinary retention, or who are taking other sedating or interacting medications. They should also be avoided in patients who have history of drug abuse or dependence [57].

5.6 Considerations for drug therapy in special populations

Some special populations may require different or additional considerations for drug therapy for neck pain. These include pregnant or breastfeeding women, elderly patients, pediatric patients, and patients with comorbidities or polypharmacy. For example, pregnant or breastfeeding women should avoid NSAIDs, opioids, muscle relaxants, and most antidepressants and anticonvulsants due to the potential risks to the fetus or the infant [64]. Elderly patients may have increased sensitivity or reduced clearance of some drugs and may be more prone to adverse effects or drug interactions [65]. Pediatric patients may have different pharmacokinetics or pharmacodynamics of some drugs and may require dose adjustments or monitoring [66]. Patients with comorbidities or polypharmacy may have contraindications or interactions with some drugs and may require dose adjustments or monitoring [67]. Therefore, these special populations should consult their health care providers before using any pharmacological agents for neck pain and follow their recommendations carefully [57].

6. Interventional and Surgical Approaches for neck pain

Some patients with neck pain may not respond to conservative treatments such as medications, physical therapy, or complementary and alternative therapies. In these cases, interventional and surgical approaches may be considered to provide more effective and lasting pain relief, improve function and quality of life, and prevent further complications. However, these approaches also carry higher risks and limitations, and should be reserved for carefully selected patients who have clear indications, realistic expectations, and informed consent [68]. The following is a brief overview of some of the interventional and surgical approaches for neck pain, with references to relevant sources.

6.1 Cervical injections (corticosteroids, anesthetics)

Cervical injections are procedures that involve injecting a local anesthetic, a corticosteroid, or both into specific structures or regions of the cervical spine, such as the epidural space, the facet joints, the nerve roots, or the trigger points. The local anesthetic provides immediate but temporary pain relief by blocking the transmission of pain signals from the affected area. The corticosteroid provides longer-term but variable pain relief by

reducing inflammation and swelling around the affected area. Cervical injections can be used for diagnostic or therapeutic purposes, or both. They can help identify the source of neck pain, confirm the response to treatment, and deliver medication directly to the target site. Cervical injections can be effective for various causes of neck pain, such as cervical radiculopathy, cervical facet joint syndrome, cervical spondylosis, or myofascial pain syndrome [69].
However, cervical injections also have potential risks and limitations. They can cause side effects such as bleeding, infection, nerve damage, spinal cord injury, allergic reaction, or systemic effects of corticosteroids. They can also have variable efficacy depending on the technique, accuracy, volume, concentration, and frequency of the injections. They can also have a placebo effect or a tachyphylaxis effect (diminished response to repeated doses). They are not curative and do not address the underlying cause of neck pain. They should be used as part of a comprehensive multidisciplinary pain management program that includes other modalities such as medications, physical therapy, behavioral therapy, and lifestyle modifications [70].

6.2 Nerve blocks and radiofrequency ablation
Nerve blocks are procedures that involve injecting a local anesthetic or a neurolytic agent (such as alcohol or phenol) into specific nerves or nerve bundles that are responsible for transmitting pain signals from the affected area. The local anesthetic provides immediate but temporary pain relief by blocking the transmission of pain signals from the affected area. The neurolytic agent provides longer-term but irreversible pain relief by destroying the nerve fibers and preventing them from regenerating. Nerve blocks can be used for diagnostic or therapeutic purposes, or both. They can help identify the source of neck pain, confirm the response to treatment, and deliver medication directly to the target site. Nerve blocks can be effective for various causes of neck pain, such as cervical radiculopathy, cervical facet joint syndrome, cervical spondylosis, or myofascial pain syndrome [71,72].
Radiofrequency ablation is a procedure that involves applying an electric current through a needle electrode to specific nerves or nerve bundles that are responsible for transmitting pain signals from the affected area. The electric current generates heat that damages the nerve fibers and prevents them from transmitting pain signals. Radiofrequency ablation provides longer-term but reversible pain relief by creating a lesion in the nerve tissue that can heal over time. Radiofrequency ablation can be used for therapeutic purposes only. It can help deliver treatment directly to the target site without affecting other nerves or structures. Radiofrequency ablation can be effective for various causes of neck pain, such as cervical radiculopathy, cervical facet joint syndrome, or cervical spondylosis [72,73].
However, nerve blocks and radiofrequency ablation also have potential risks and limitations. They can cause side effects such as bleeding, infection, nerve damage, spinal cord injury, allergic reaction, or systemic effects of local anesthetics or neurolytic agents. They can also have variable efficacy depending on the technique, accuracy, volume, concentration, and frequency of the injections or applications. They can also have a placebo effect or a tachyphylaxis effect (diminished response to repeated doses). They are not curative and do not address the underlying cause of neck pain. They should be used as part of a comprehensive multidisciplinary pain management program that includes other modalities such as medications, physical therapy, behavioral therapy, and lifestyle modifications [72].

6.3 Surgical options for specific neck conditions (e.g., herniated discs, spinal stenosis)
Surgical options are procedures that involve removing, replacing, or stabilizing parts of the cervical spine that are causing pain or compressing the spinal cord or nerve roots. Surgical options can be effective for specific neck conditions that have failed to respond to conservative treatments or that pose a risk of neurologic impairment or deterioration. Some of the common surgical options for neck pain include:

Anterior cervical discectomy and fusion (ACDF). This is a procedure that involves removing a herniated or degenerated intervertebral disc that is causing pain or compressing the spinal cord or nerve roots. The disc space is then filled with a bone graft or an artificial implant and fused with metal plates and screws to stabilize the spine. ACDF can relieve neck pain, radicular pain, and myelopathic symptoms caused by cervical disc herniation, cervical spondylosis, or cervical stenosis [74].

Cervical disc arthroplasty (CDA). This is a procedure that involves replacing a herniated or degenerated intervertebral disc with an artificial disc that mimics the natural motion and function of the disc. CDA can preserve the mobility and flexibility of the spine and prevent adjacent segment degeneration. CDA can relieve neck pain, radicular pain, and myelopathic symptoms caused by cervical disc herniation, cervical spondylosis, or cervical stenosis [74].

Posterior cervical laminectomy and fusion (PCLF). This is a procedure that involves removing part or all of the lamina (the bony arch of the vertebra) and any bone spurs or ligaments that are causing pain or

compressing the spinal cord or nerve roots. The spine is then stabilized with metal rods and screws. PCLF can relieve neck pain, radicular pain, and myelopathic symptoms caused by cervical stenosis, cervical spondylolisthesis, or cervical tumors [75].

Posterior cervical foraminotomy (PCF). This is a procedure that involves removing part of the facet joint and any bone spurs or soft tissue that are causing pain or compressing the nerve root. PCF can relieve radicular pain caused by cervical foraminal stenosis or cervical disc herniation [75].
However, surgical options also have potential risks and limitations. They can cause complications such as bleeding, infection, nerve damage, spinal cord injury, implant failure, nonunion, pseudoarthrosis, adjacent segment degeneration, or chronic pain. They can also have variable outcomes depending on the patient's age, health status, comorbidities, preoperative symptoms, and postoperative rehabilitation. They are not guaranteed to provide complete or permanent pain relief or functional improvement. They should be reserved for carefully selected patients who have clear indications, realistic expectations, and informed consent.

6.4 Efficacy, risks, and limitations of interventional and surgical approaches

The efficacy, risks, and limitations of interventional and surgical approaches for neck pain depend on various factors such as the type, cause, severity, and duration of neck pain; the patient's preferences, comorbidities, and potential drug interactions; the availability, accessibility, and affordability of the interventions; the expertise, experience, and equipment of the providers; and the quality, quantity, and consistency of the evidence [76]. Therefore, it is difficult to make generalizations or comparisons about the relative benefits and harms of different interventional and surgical approaches for neck pain. However, some general principles can be applied:

- Interventional and surgical approaches should be considered only after failure to achieve adequate pain relief with conservative treatments such as medications, physical therapy, or complementary and alternative therapies.
- Interventional and surgical approaches should be tailored to the individual patient's needs, goals, preferences, values, and expectations.
- Interventional and surgical approaches should be based on the best available evidence from high-quality studies such as randomized controlled trials, systematic reviews, meta-analyses, clinical practice guidelines, and expert consensus statements.
- Interventional and surgical approaches should be performed by qualified, trained, experienced, and competent providers who adhere to strict standards of safety, quality, ethics, and professionalism.
- Interventional and surgical approaches should be evaluated regularly for their effectiveness, safety, cost-effectiveness, patient satisfaction, and impact on function and quality of life.
- Interventional and surgical approaches should be integrated with other modalities of pain management such as medications, physical therapy, behavioral therapy, lifestyle modifications, self-care strategies, patient education, and social support [77].

7. Emerging Therapies

7.1 Virtual reality and tele-rehabilitation

Individuals dealing with neck pain often experience various physical limitations, including pain, changes in muscle strength, altered sensory functions, and restricted joint movements. In recent times, virtual reality (VR) has emerged as a notable approach in both evaluating and addressing neck pain. This method involves engaging patients in virtual games that incorporate a set of predetermined exercises aimed at enhancing various movement aspects such as range, speed, smoothness, accuracy, and reaction time. The design of VR-based exercise games for neck pain needs to prioritize safety, motivation, controlled repetitions, diverse feedback mechanisms, and the creation of a multisensory environment to fully immerse the user. The application of VR technology in patients with neck pain has demonstrated positive outcomes, including the reduction of pain and disability, improvement in movement capabilities, and enhancement of postural control. Through VR, there is potential to decrease the perception of pain, enhance overall function and mobility, boost motivation and adherence to treatment regimens, and support individuals in managing their condition independently [78].
Telerehabilitation refers to the provision of rehabilitation services through various telecommunication technologies, including websites, smartphone applications, videoconferencing systems, and telephone platforms. This approach allows individuals to receive rehabilitation support remotely, eliminating the need for in-person visits [79]. Telerehabilitation interventions have gained increasing popularity in recent times due to advancements in technology and telecommunication methods [80]. Individuals often opt for telerehabilitation interventions as a means to circumvent lengthy waiting lists, minimize expenses, overcome transportation limitations, or for various other reasons [80,81]. Approximately twenty percent of individuals experiencing neck pain in rural areas seek primary health care services. However, these individuals often encounter challenges when attempting to access healthcare due to the combination of long distances and lengthy waiting lists [80,82].

Consequently, it appears that these individuals could potentially find value in utilizing telerehabilitation interventions. The utilization of telerehabilitation in addressing neck pain holds promise, especially for a significant segment of the population with constrained access to conventional healthcare services [83,84].

7.2 Mind-body therapies

Mind-body therapy focuses on training the mind to become more in tune with its surroundings and experiences, and how they may be affecting the body's pain levels. Most mind-body therapies aim to reduce stress levels, such as by practicing relaxation or becoming aware of stressors in order to better manage them. Breathing tends to quicken with stress and anxiety. Becoming aware of one's own respiration and concentrating on slowly breathing in and out can have a calming effect. Guided imagery is a therapy to help the mind focus on images, metaphors, or stories that may bring the patient a sense of control and/or a calming effect. Many types of guided imagery are performed—or at least started—in an office setting with a therapist or other trained health professional. Research indicates that expressing and articulating emotions can help reduce stress and may also contribute to improved thinking. Some people may achieve these same benefits by regularly writing thoughts and feelings in a private journal [85,86]. While there is currently a lack of substantial randomized controlled trial (RCT) studies providing strong evidence for the direct reduction of chronic neck pain through mind-body therapies, the body of research is growing in support of these therapies' potential to alleviate stress and inflammation. Many individuals have reported experiencing pain relief benefits from engaging in mind-body therapies, even though large-scale RCTs with definitive evidence are still limited in this specific context. The accumulating evidence highlights the potential for mind-body therapies to contribute positively to pain management and overall well-being, despite the need for further comprehensive studies.

7.3 Chiropractic spinal manipulation

Chiropractic is a healthcare profession that focuses on managing conditions related to the muscles, nerves, and skeletal system, with a particular emphasis on addressing disorders that impact the spine [87]. Chiropractors often utilize manual therapy, with a primary focus on spinal manipulation (SM), which is a central component of their treatment approach. In the context of managing acute and chronic neck pain, two clinical trials have compared the effectiveness of adding Spinal Manipulation Therapy to standard physical therapy treatments. These trials investigated the potential benefits of combining SM with treatments like electric or thermal stimulations, along with educational material, to address neck pain [88,89]. In both of these trials, the inclusion of thoracic Spinal Manipulation Therapy (SMT) led to more significant reductions in both pain intensity and disability levels. These positive effects were observed to last for a duration of up to 6 months [90,91]. Interestingly, in a different scenario, a single session of cervical Spinal Manipulation Therapy (SMT) did not demonstrate greater effectiveness compared to the use of Kinesio taping for managing neck pain (NP). Kinesio taping is a technique commonly utilized in physical therapy practice [92]. This observation could potentially be interpreted as additional evidence suggesting that cervical Spinal Manipulation Therapy (SMT) might be less effective compared to thoracic SMT. However, it's important to note that the available evidence for making such a comparison is still limited, and further research is needed before drawing definitive conclusions [93].

In a study involving individuals with acute and subacute neck pain, a trial compared the effects of Spinal Manipulation Therapy (SMT) with medication (acetaminophen, non-steroidal anti-inflammatory drugs, or a combination) and a home exercise program with advice. The findings of this study indicated that SMT was more effective in reducing pain and improving outcomes compared to medication. However, there was no significant difference in effectiveness between SMT and the home exercise program with advice [94]. Similarly, there were no notable differences in pain and disability outcomes between groups one week after either a home exercise program or a single session of Spinal Manipulation Therapy (SMT) in patients with chronic neck pain [95]. The data indicate that Spinal Manipulation Therapy (SMT) does not appear to offer greater benefits than home exercise, although they don't definitively establish whether SMT provides additional advantages when combined with exercise therapy. Furthermore, incorporating a single session of manual Spinal Manipulation (as opposed to instrumental manipulation) into a stretching exercise regimen was found to be more effective in reducing neck pain intensity compared to the control exercise program used alone [96]. Similar outcomes were observed when two sessions of thoracic Spinal Manipulation (SM) were incorporated into an exercise program, which involved both in-person guidance from a physical therapist and home-based exercises [97]. These findings suggest that the addition of one or two sessions of Spinal Manipulation Therapy (SMT) might provide benefits when combined with exercise therapy for short-term relief of neck pain. However, over the long term, supervised exercise with or without SMT was more effective than a home exercise program alone in reducing chronic neck pain intensity [98].

8. Multidisciplinary and Collaborative Care

Neck pain is a complex and multifaceted condition that can affect various aspects of a person's health and well-being. It can be caused by various factors, such as injury, degeneration, inflammation, posture, stress, or

psychosocial issues. It can also have various consequences, such as pain, disability, reduced quality of life, impaired work performance, or psychological distress. Therefore, the management of neck pain requires a comprehensive and holistic approach that addresses the physical, psychological, and social dimensions of the problem [76].

8.1Importance of a team-based approach in neck pain management

A team-based approach to neck pain management entails the collaborative efforts of various health professionals, each bringing distinct skills, knowledge, and expertise to the assessment and treatment of neck pain and its related disorders. This multidisciplinary strategy offers multiple benefits to patients. It enhances access to a broad spectrum of services and interventions specifically tailored to meet the individual needs and preferences of the patient. Furthermore, it fosters improved communication and coordination among the health professionals involved, potentially reducing the duplication, confusion, or inconsistency in the information or advice provided. Such an approach not only increases patient satisfaction, engagement, empowerment, and self-management skills, but it also leads to better adherence to treatment plans and improved outcomes. Additionally, a team-based approach can lead to reduced costs and more efficient use of resources, thereby increasing the overall efficiency and effectiveness of care [99].

8.2 Coordination between physiotherapists, physicians, pain specialists, psychologists, etc.

Effective coordination among physiotherapists, physicians, pain specialists, psychologists, and other health professionals is crucial for optimal care delivery and patient outcomes in the management of neck pain. Achieving this coordination involves several strategic approaches. Firstly, it is important to establish clear roles and responsibilities for each team member while also defining the scope and goals of their respective interventions. Additionally, developing a shared care plan is essential; this plan should outline the diagnosis, prognosis, treatment options, expected outcomes, and follow-up arrangements for each patient. Regular meetings or consultations among the team members are also vital. These meetings serve as opportunities to discuss the progress of each patient, address any challenges, or make necessary adjustments to the care plan. Using standardized tools or platforms ensures that all relevant information and data are well-documented and communicated efficiently among the team members. Finally, it is important to include patients in the decision-making process by seeking their feedback and involving them in discussions about their care plan, thereby enhancing the effectiveness and personalization of the treatment [100].

9. Future Directions and Research Gaps in neck pain management

Promising areas for future research in neck pain management are vast and diverse. Developing and validating new tools or biomarkers for early detection, diagnosis, prognosis, and treatment response, particularly for neuropathic or inflammatory conditions, is critical. Research into the mechanisms and pathways involved in neck pain, such as genetics, epigenetics, neuroplasticity, inflammation, oxidative stress, and the role of the microbiome, is essential for understanding the initiation and maintenance of neck pain. Evaluating the effectiveness, safety, cost-effectiveness, and patient satisfaction of various treatments—both pharmacological and non-pharmacological—is vital. This includes exploring novel drugs, injections, devices, surgeries, as well as physical, psychological, and complementary therapies, and multidisciplinary approaches. Additionally, studying the impact of neck pain on health and well-being aspects such as function, mobility, sleep, cognition, and social interactions can provide deeper insights. Identifying risk and protective factors, along with moderators and predictors of neck pain's onset, severity, and chronicity, is also a priority, alongside strategies for prevention, education, self-management, and patient empowerment.

Current gaps in the literature include the lack of standardized definitions, classifications, criteria, and outcome measures for neck pain and its associated disorders. There's a notable deficiency in high-quality studies featuring large sample sizes, long follow-up periods, adequate control groups, and rigorous methodologies. Comparative effectiveness research that evaluates different interventions across various settings and populations is scarce, as is patient-centered research that accounts for the preferences and expectations of patients and their caregivers. Furthermore, translational research that effectively bridges basic science, clinical practice, and policy making remains limited.

Research priorities for advancing neck pain treatment and understanding include conducting systematic reviews, meta-analyses, and developing evidence-based guidelines to synthesize existing evidence and recommend best practices. Designing randomized controlled trials, pragmatic trials, and adaptive trials to test new or existing interventions in real-world settings is crucial. Subgroup analyses, stratified analyses, or personalized medicine approaches can help identify optimal interventions for individual patients based on their specific characteristics and needs. Employing innovative technologies like virtual reality, tele-rehabilitation, wearable devices, or artificial intelligence can enhance the delivery and evaluation of neck pain interventions. Finally, engaging patients and their caregivers as partners in the research process ensures the relevance and applicability of research findings, from planning through to dissemination.

Conclusion

In conclusion, this comprehensive review elucidates the multifaceted landscape of neck pain management. By delving into the anatomical foundations, biomechanical intricacies, and various causative mechanisms, we gain a holistic understanding of this pervasive health concern. The classification and assessment methods highlighted emphasize the need for nuanced approaches to diagnosis and evaluation. Non-pharmacological strategies encompassing physical therapy, manual techniques, posture correction, and cognitive-behavioral therapy offer personalized interventions that address both physical and psychological dimensions. Pharmacological management, interventional procedures, and surgical options provide a spectrum of choices tailored to individual needs. The emergence of complementary therapies like virtual reality and chiropractic care adds novel dimensions to the therapeutic repertoire. Recognizing the power of collaboration, the importance of multidisciplinary care models underlines the significance of coordinated efforts among various healthcare professionals. While acknowledging current research gaps, this review identifies promising avenues for future exploration, shaping the trajectory of neck pain management. In summary, the culmination of insights emphasizes the necessity of a patient-centric approach, where comprehensive strategies intertwine with ongoing research endeavors. Through the integration of evidence-based practices, the informed clinician can pave the path toward effective neck pain alleviation, fostering improved clinical outcomes and an enhanced quality of life for those affected.

AUTHORS' CONTRIBUTIONS

All authors have accepted responsibility for the entire content of this manuscript and contributes equally.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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