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Conference Paper

Spinal Manipulation as a Treatment for Neck Pain: A Systematic Review of Randomized Controlled Trials

La manipulación espinal como tratamiento para la cervicalgia: Una revisión sistemática de ensayos controlados aleatorizados

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Abstract

Background: Cervical pain is one of the most common pathologies in physiotherapy consultations. Currently, there are countless techniques, protocols, and treatments ranging from conservative to invasive. The intervention includes orthopedic manual therapy techniques in patients who present the pathology. To date, several studies apply spinal manipulation as a treatment option for patients with neck pain; however, its effects on pain and disability are unknown. Methodology: A compilation, selection, and analysis of randomized clinical trials was carried out, and studies showed the effect of this technique on the type and origin of pain in patients with neck pain. Data extraction was formulated in tables, and the methodological quality was determined through the physiotherapy evidence database scale. Results: Thirty studies were included that were classified based on the type and origin of pain. In order to determine the effectiveness, it was applied as the only treatment technique or as part of a multimodal treatment. Conclusions: Spinal manipulation has a greater effect on pain and disability when considered as the only treatment technique in patients with acute pain. However, when applied as part of the multimodal protocol, it proves to be effective in chronic, radicular, mechanical, and nonspecific pain. The high heterogeneity of the studies is a limitation of our findings.

Keywords: *spinal manipulation, neck pain, cervical vertebral, acute pain, chronic pain.*

Resumen

Antecedentes: El dolor cervical es una de las patologías más comunes presente en la consulta de fisioterapia, en la actualidad existen un sin número de técnicas, protocolos y tratamientos que van desde lo conservador hasta lo invasivo, en la intervención se incluye técnicas de terapia manual ortopédica en pacientes que presentan la patología antes mencionada. Hasta la fecha, existen varios estudios que aplican manipulación espinal como opción de tratamiento para pacientes con dolor cervical, sin embargo, se desconocen sus efectos sobre dolor y la discapacidad. Metodología: se realizó la recopilación, selección y análisis de ensayos clínicos aleatorizados que en sus estudios se evidenció el efecto de esta técnica sobre el tipo y origen del dolor en pacientes con cervicalgia, la extracción de datos se formuló en tablas;

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la calidad metodológica fue determinada a través de la escala de Physiotherapy Evidence Database, Resultados: se incluyeron treinta estudios que fueron clasificados en base al tipo y origen del dolor, para determinar la efectivad, se tomó en cuenta si era aplicada como única técnica de tratamiento o siendo parte de un tratamiento multimodal. Conclusiones: la manipulación espinal tiene mayor eficacia sobre el dolor y la discapacidad al ser considerada como única técnica de tratamiento en pacientes con dolor agudo; sin embargo, cuando es aplicada como parte del protocolo multimodal demuestra ser eficaz en el dolor crónico, radicular, mecánico e inespecífico, la alta heterogeneidad de los estudios es una limitante para nuestros hallazgos.

Palabras Clave: *manipulación espinal, cervicalgia, vértebras cervicales, dolor agudo, dolor crónico.*

1. Introduction

Cervical pain is usually a prevalent problem in primary health care settings, making it the fourth pathology that causes the greatest disability in the adult population (1). Its symptoms are directly related to the pain present in the posterior and lateral regions of the neck, between the nuchal line and the first thoracic vertebra, which causes a loss of mobility and therefore less functionality (2, 3). There are several ways to classify pain according to the origin of the structural dysfunction, as it is divided into mechanical, nervous, and non-specific. And regarding the time that the condition lasts, it can be acute with a duration of less than six weeks, while when it lasts more than three months, it is called chronic pain.

Pain of mechanical origin at the cervical level is characterized by algia, which is present when the patient tends to maintain certain postures for prolonged periods of time, and which is exacerbated when they perform movements that involve the cervical segment. It has an average annual prevalence of 37%. Its symptoms are directly related to pain and sensory integration. Generally, it causes a decrease in joint range at the cervical, cervico-thoracic, and glenohumeral levels, dizziness, and alterations in the sensorimotor system, with a tendency to affect posture and balance (4).

Pain of radicular or nerve origin in the neck is most prevalent between the fourth and fifth decades of life, affecting 3.3 per 1,000 people. Its etiology is directly related to disc protrusions and the presence of osteophytes. These two injuries tend to compress the nerve roots, causing pain and inflammation that leads to symptoms that generally extend to the ipsilateral upper limb, causing loss of both mechanical and nervous physiological functions (5).

Cervical pain is directly related to cervical spine disorders. These may involve structures: bone, disc, joint or nerve, causing neck pain with a prevalence of 53% of the population with a history of whiplash. The symptoms reported by these patients include

headache, pressure pain in the upper cervical region, decreased joint range, motor control dysfunction, and sustained cervical postures (6).

Acute cervical pain (7), derived from mechanical pain, occurs insidiously, and has a multitude of causes, such as poor posture, occupational stress, or sports activities. It produces a decrease in mobility due to muscle spasm or active trigger point; it affects the joint range of motion (ROM); it may or may not present interference in the activities of daily living; this condition resolves in three to four weeks.

Its diagnosis is based on the absence of behaviors that suggest a more serious pathology. The most important thing is to take the correct anamnesis and complementary analyses. This type of ailment responds to conventional treatments, although the optimal approach remains undefined (8).

From a biopsychosocial point of view, there are a significant number of factors that contribute to neck pain. Many of them are not modifiable, such as trauma history, age, gender, and genetics itself. In addition, there are adjustable ones such as smoking, level of physical activity, sedentary lifestyle, coping style in situations, and job satisfaction. All the above are contributors to the transition from acute to chronic neck pain. When the duration of the symptoms exceeds twelve weeks, it acquires the value of chronicity (9), being called chronic nonspecific cervicalgia (10).

Chronic neck pain is one of the most prevalent pathologies today since it represents 14.6% of all musculoskeletal health problems (11). The chronicity of this state generates a great impact on the patient's life by creating inconveniences within their activities of daily living (ADL), resulting in prolonged disability. The mechanism by which pain becomes chronic is not entirely clear, but it could be associated with an alteration in the proprioception of the neck muscles, which play a decisive role in the position of the cervical joint and motor control of the head (9).

Because the condition exceeds the estimated healing time of the tissue, this type of pain contributes to the disability of those who suffer from it. It has a prevalence in adults of 20% and increases as the population ages. The World Health Organization (WHO) attributes chronic pain as a public health problem due to its exponential growth internationally. Since suffering from chronic pain causes the quality of life to decrease, health costs tend to become more expensive (12).

Cervical pain has a close relationship with psychological variables since this influences the intensity of the pain, certain moods, and depression. They can complete the picture with catastrophizing in the face of pain and chronicity. Therefore, this condition can be described as multifactorial and runs in the posterior and lateral parts of the neck, between the nuchal line and the spinous process of the fifth vertebra. At the time of

the examination, there are no signs or symptoms of major structural pathology; that is, there are no neurological or traumatological signs (13).

Cervical pain has a clear relationship with reduced productivity. Together with low back pain, it is one of the ailments with the highest incidence in the population. For example, in the United States, it is typically referred to by office workers because it has a clear relationship with the reduction of work. It is convenient to refer to the epidemiology of neck pain given the increase in incidence and prevalence in many regions of the world. The author (13) emphasizes that most people who suffer from neck pain are women, thus increasing the number of years lived with disability, all because of the pain. Therefore, the risk factors would be female sex, being over forty years old, doing little physical activity, and spending a high number of hours in front of a computer, to which are added certain psychological conditions such as stress or anxiety (14).

There is no specific treatment for neck pain; it all depends on contextual factors and the individuality of the patient's condition, which is why they are frequently referred to as waiting for the natural course of the condition. Combining it with anti-inflammatory medications (NSAIDs): when this strategy has failed, other options are considered to alleviate the condition, such as the use of secondary analgesic drugs. In addition, prolonged immobilization using an orthopedic collar, infiltrations, physiotherapy, alternative therapies, and even surgery (15).

A safe option with proven effects in conservative treatment is physiotherapy, which addresses non-invasive and low-cost treatments through different types of assisted or free exercises. These include manual therapy, electrotherapy, massage therapy, and the use of orthopedic devices focused on cervical immobilization (16).

Various clinical trials opt for physiotherapy treatment to treat patients with neck pain. Highlighting manual therapy with spinal manipulation/mobilization techniques (SMT) that aim to reduce pain, improve proprioception, joint range, balance, posture, normalize somatosensory information and therefore disability. SMT techniques attempt to apply distraction forces to varying degrees. Slowly, rhythmically, and oscillatingly, combined with low or high speed on the cervical segments in order to separate them or produce a safe movement, improving and providing analgesia. Thus, favoring the range of motion which in turn improves the functional aspects of the patient (4).

The physiological principle of SMT is directly related to the reduction mechanisms of orthopedic manual therapy (OMT). These are linked to the reduction of neurophysiological biomarkers such as inflammatory biomarkers, decreased spinal excitability, modification of activity in cortical areas involved in pain processing, and excitation of the Sympathetic Nervous System (SNS) (17). On the other hand, although therapeutic

exercise has also shown neurophysiological effects, it involves the reorganization of motor and structural patterns, adaptations, and an increase in strength and resistance (18). The two treatments have been effective, but as they have different mechanisms of action, the duration of the effects and their evolution could be different (17).

SMT can affect the interaction of inflammation thanks to peripheral mediators and nociceptors that occur after tissue injury by modifying the concentration of substances that mediate inflammation and pain (19).

The main objective of this systematic review of clinical trials is to determine the effect of SMT on pain and disability in neck pain. The secondary objectives were to determine the effect of intervention with SMT as the only treatment technique or combined with multimodal interventions. Additionally, describe the effect of SMT on acute and chronic pain, according to the origin of the pain.

2. Methodology

The present investigation is a systematic review of randomized clinical trials that analyzed the effectiveness of SMT as a single treatment technique or in a multimodal combination on pain and disability in patients with neck pain.

2.1. Research strategy

It has been searched and compiled through the main scientific databases, such as PubMed, Scopus, Research Gate, and Scielo. Clinical studies work by combining keywords such as neck pain, neck ache, cervical pain, cervicalgia, manipulation, manual therapy, and spinal mobilization therapy. In order to obtain more detailed results, the Boolean operators “AND, OR, NOT” were used. The information collected was processed through tables, which included the year of publication of the study, the intervention method, and its results.

To ensure veracity, the Physiotherapy Evidence Database (PEDro) has been used to assess the methodological quality of each research work, accepting those that met a minimum value of 6 on the scale.

Figure **1** shows the flow chart of the collection and selection process of the studies considered in this review.

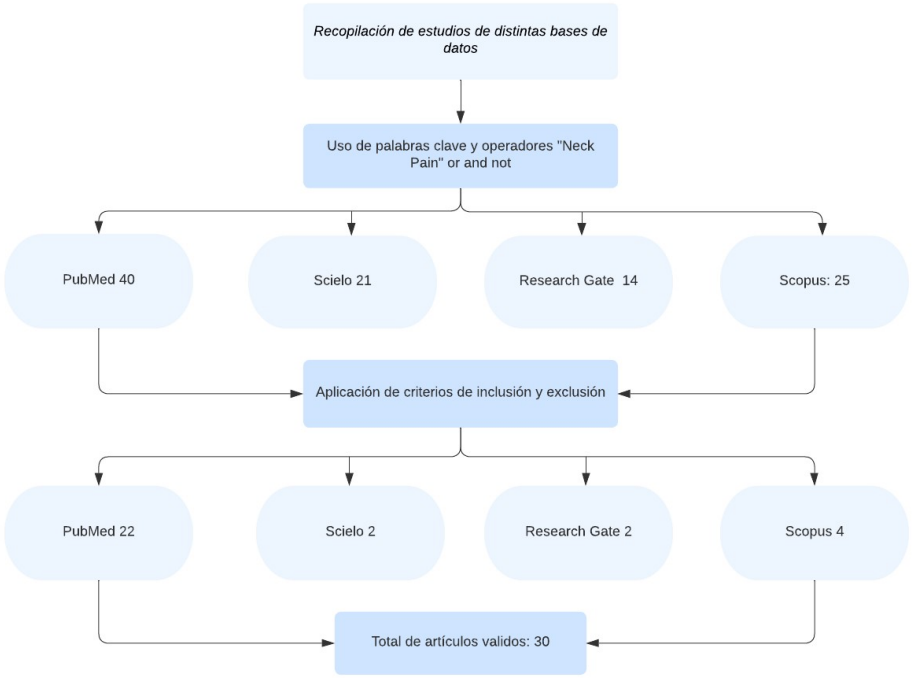

Figura 1

Description: Flowchart with the articles included in this review.

2.2. Inclusion criteria

The effect of SMT in patients with neck pain was determined from the collection, selection, and analysis of clinical trials carried out in adult humans. These studies applied the technique as part of the intervention protocol, which was followed and controlled by physiotherapists with prior knowledge of BMT.

The clinical trials included in this systematic review involved patients with acute neck pain lasting three to four weeks or chronic neck pain lasting more than twelve weeks. Specific tests for the diagnosis and assessment of neck pain were evident, as demonstrated by standardized medical records that included age, sex, duration of symptoms, nature, and location of symptoms. Mechanisms of injury, questions about aggravating and relieving factors, as well as any history of neck injury. The physical examination began with observation, followed by neurological examinations that check dermatomes, neural tension tests, the Spurling test, the Valsalva test, or the cervical distraction test. These aim to evoke the patient's symptoms and complement imaging tests such as diagnostic imaging studies (XR), computed axial tomography (CAT), and magnetic resonance imaging (IMR) to identify the origin of the pain.

Articles published from 2011 to 2023 in English, Portuguese, or Spanish were included. The studies that make up this systematic review have been used to investigate the pre- and post-intervention status of SMT on pain and disability. To determine the incidence, they used the Visual Analog Scale (VAS) or the numerical pain scale (NPRS). For disability through the Neck Disability Index (NDI).

2.3. Exclusion criteria

Within the corresponding filtering, an analysis was carried out on the years of publication of the documents included at the beginning of the investigation. Followed by an exhaustive assessment of the parameters of the evidence in physiotherapy, known as the Physiotherapy Evidence Database (PEDro). In addition to being an assessment scale, it is also considered a bibliographic database that contains randomized trials, clinical practice guidelines, and systematic reviews in the field of physiotherapy. The essays are evaluated independently in terms of their quality using the scale, thus obtaining a score less than or equal to six.

Works used to evaluate pain and disability, as well as other scales or questionnaires other than those mentioned above. In addition, studies involving patients with cervical pain with the following etiology: tumors, neoplasms, spinal cord tumors, multiple myeloma, chordoma, rheumatoid arthritis, or infectious processes that included epidural abscess or meningitis were discarded. Studies that show previous cervical trauma or cervical spine surgery. Individuals with contraindications for SMT such as fracture, osteoporosis, joint infections, or vertebrovasilar insufficiency, among others, Studies with a diagnosis of cervical radiculopathy, having been treated with manual therapy in the last three months, and receiving other treatment while the study is ongoing.

2.4. Review process

The information was collected by two researchers from different databases consulted with the highest incidence in physiotherapy. A third researcher filtered the investigations by the variables of interest, while the fourth researcher analyzed the collected studies for their scientific validity. The four researchers reviewed indices, scales, and questionnaires used to determine the effect of SMT on pain and disability in patients with neck pain.

For the data review, the studies were selected and validated; consequently, the score of each of the tests that assessed both pain and disability, the intervention, results, and conclusions of each of the studies were analyzed.

3. Development and discussion

The present systematic review compiled information from thirty randomized clinical trials on cervical pain that used SMT within their intervention protocol as a sole treatment technique or in combination with therapeutic exercise, neural mobilization, myofascial induction, traction, and dry needling. Pain has been classified according to its root, mechanical, and non-specific origin and according to the type of pain, acute or chronic. It was subsequently analyzed based on the results obtained from research on pain measured with the VAS and NPRS scales. Disability with NDI with the objective of determining the effect of SMT on pain and disability in patients with cervical pain. Furthermore, describe its effect as the only treatment technique or combined with multimodal interventions on acute and chronic pain, according to the origin of the pain.

SMT analysis of the origin of pain.

The randomized clinical trials analyzed apply SMT in patients with neck pain of radicular [8], mechanical [8] and non-specific origin [2]. Involving 18 investigations that correspond to 60% of studies analyzed in this systematic review. The interventions involve protocols according to the origin of the pain.

In radicular pain, SMT tends to be used in 50% of studies (5, 20–22) as the only treatment technique; studies show results from the first to the twelfth intervention. The remaining percentage is divided based on multimodal protocols. 25% of the studies combine (16, 23) SMT with therapeutic exercise with six interventions, and the remaining 25% of studies (24, 25) combine SMT with neural mobilization with results from the sixth to the twelfth intervention.

The results of SMT interventions on radicular pain, considering the VAS and NPRS scales, were analyzed based on the intervention protocol. SMT as the only treatment technique presented an average initial pain of 7 after an average of 9 interventions, detailing a final average of 4 points, obtaining 3 points of pain reduction. Regarding multimodal protocols, SMT combined with therapeutic exercise presents an average initial pain of 6 points, and subsequently, with an average of 6, intervention presents a final average of 3, obtaining 3 points of pain reduction. The protocol that combines SMT with neural mobilization presents an average initial pain of 7 and then, with an average of nine interventions, ends with an average final pain of 2, obtaining 5 points of pain reduction (Table I). Therefore, multimodal protocols that combine SMT with neural mobilization demonstrate greater effectiveness in terms of radicular pain.

Regarding disability, the SMT on radicular pain was considered in 4 investigations (6, 16, 23, 26) that used the NDI as an assessment index. Interventions include two 50% SMT studies with therapeutic exercise. Detailing an initial average between 37 and 38

points and after the intervention ending with a final average of 16 points and a score in favor of quality of life of 22 points. An intervention that corresponds to 25% and includes SMT as the only treatment technique has an initial average of 22 and, after the intervention, a final average of 10 with a score in favor of quality of life of 12 points. The remaining 25% corresponds to research that combines SMT with neural mobilization with an initial average of 24 and, after the intervention, a final average of 5 points with a score in favor of quality of life of 19 points (Table I). Therefore, multimodal protocols that combine SMT with therapeutic exercise demonstrate a greater effect in terms of disability in patients with pain of radicular origin.

In pain of mechanical origin, SMT tends to be used in 75% of the studies (2, 4, 27–30) as the only treatment technique; studies show results from the first to the fifteenth intervention. The remaining percentage is divided based on multimodal protocols. 12.5% of studies (31) combine SMT with dry needling with eight interventions, and the remaining 12.5% of studies (32) combine SMT with thoracic manipulation with two interventions.

The results of interventions with SMT on pain of mechanical origin were analyzed based on the VAS and NPRS pain scales. The intervention protocols used SMT as the only treatment technique in 75% of the interventions. This presented an average initial pain of 5; after an average of 5, the intervention detailed a final average of 3 points, obtaining 2 points of pain reduction. Regarding multimodal protocols, 12.5% use SMT combined with dry needling, presenting an average initial pain of 6. After an average of 8 interventions, they present a final average of 2, obtaining 4 points of pain reduction. Finally, the remaining 12.5% use SMT combined with thoracic manipulation, presenting an average initial pain of 5 and after an average of 2 interventions. It ends with an average final pain of 2, obtaining 3 points of pain reduction (Table I). Therefore, multimodal protocols that combine SMT with thoracic manipulation demonstrate greater effectiveness in terms of pain of mechanical origin.

Regarding disability, studies that use SMT on pain of mechanical origin involve two investigations that correspond to 25% of studies. The remaining 75% focus on pain but not on the disability caused by pain of mechanical origin. The randomized clinical trials analyzed for disability used the NDI as an assessment index, and the interventions included are entirely multimodal. A study of 12.5% uses SMT combined with dry needling that details an initial average of 21 points, and the intervention ends with a final average of 13 points with a score in favor of quality of life of 8 points. A 12.5% intervention that includes SMT combined with thoracic manipulation detailed an initial mean of 22 and, after the intervention, a final mean of 10 with a score in favor of quality of life of 12 points. The remaining 25% corresponds to research that

combines SMT with neural mobilization. This details an initial average of 29 and, after the intervention, a final average of 12, with a score in favor of quality of life of 17 points (Table I). Therefore, multimodal protocols that combine SMT with thoracic manipulation demonstrate a greater effect in terms of disability in patients with pain of mechanical origin.

In pain of non-specific origin (1), 50% of studies report SMT as the only treatment technique; these studies demonstrate results in only one intervention. The remaining percentage corresponds to a multimodal protocol (50%) that combines SMT with myofascial induction with six interventions. Pain of non-specific origin is reported in 50% of the studies (1), and SMT is used as the only treatment technique. These studies demonstrate results from only one intervention. The remaining percentage corresponds to a multimodal protocol (50%) that combines SMT with myofascial (33) induction and six interventions.

The results of interventions with SMT on pain of non-specific origin were analyzed based on the previously mentioned pain scales. The intervention protocols that used 50% of the studies using SMT as the only treatment technique presented a mean initial pain of 3. After a detailed intervention, a final average of 2 points obtained 1 point of pain reduction. Regarding the multimodal protocol, 50% use SMT combined with myofascial induction, presenting an average initial pain of 5 and subsequently, after an average of 6 interventions, presenting a final average score of 2, obtaining 4 points of pain reduction (Table I). Therefore, multimodal protocols that combine SMT with myofascial induction prove to be more effective in terms of pain of non-specific origin. However, if the number of 308 interventions is considered, the protocol that uses SMT as the only treatment would present the same or better results.

Regarding disability, all studies use SMT on pain of non-specific origin as the only treatment technique or within the multimodal protocol. The randomized clinical trials analyzed for disability used the NDI as an assessment index. 50% of the interventions included correspond to research that uses SMT as the only intervention technique. This details an initial average of 11 points to conclude with a final average of 8 points and a score in favor of quality of life of 3 points. The remaining 50% corresponds to the multimodal intervention that includes SMT combined with myofascial induction, detailing an initial average of 24 and, after the intervention, a final average of 12, with a score in favor of quality of life of 12 points (Table I). . Therefore, the multimodal protocol that combines SMT with myofascial induction demonstrates a greater 319 effect in terms of disability in patients with pain of non-specific origin.

To examine the effects of SMT on the type of pain, 12 studies were included, which are part of the systematic review and were classified into: SMT applied to acute neck

Tabla 1

Clinical trials with SMT on the origin of pain.

RADICULAR SMT + ET SMT SMT SMT + ET SMT SMT SMT + MN + TC SMT **MECHANIC** SMT SMT SMT SMT + MT SMT SMT SMT SMT + PC **NONSPECIFIC**	X X X X X X	X X X X X X X X X X	X 322 X X 323 X 324 325 X 326 X 327
SMT + IMF + MN		X	X
SMT	X		X
TOTAL 18	7	11	8

Description: SMT (Spinal Manipulation), ET (Therapeutic Exercise), MN (Neural Mobilization), TC (Thoracic Traction).*SMT analysis on pain type.*

pain, which includes four studies (4, 34, 35), corresponding to 33%. and for chronic pain, 8 investigations are included, corresponding to 64%. The research involving the SMT technique includes four studies that are characterized by being treatments that have only used manipulation as a treatment technique for acute pain; therefore, patients with acute pain presented an average initial pain score of 5 and at the same time After 2 interventions, the average final pain was 3, resulting in a reduction in pain of 2 points. The analgesic effects of the technique have been produced from the first intervention, also presenting improvements in mobility. Table II. To examine the effects of SMT on the type of pain, 12 studies were included, which are part of the systematic review and were classified into: SMT applied to acute neck pain, which includes four studies (34, 35), corresponding to 33%, and for chronic pain, there are 8 investigations that correspond to 64%. The research involving the SMT technique includes four studies that are characterized by being treatments that have only used manipulation as a treatment technique for acute pain; therefore, patients with acute pain presented an average initial pain score of 5 and at the same time After 2 interventions, the average final pain was 3, resulting in a reduction in pain of 2 points. The analgesic effects of the technique have been produced from the first intervention, also presenting improvements in mobility. Table II. To examine the effects of SMT on the type of pain, 12 studies were included, which are part of the systematic review and were classified into: SMT applied to acute neck pain, which includes four studies corresponding to 33%; and for chronic pain, 8 investigations are included that correspond to 64%. The investigations that involve the SMT technique include four studies that are characterized by treatments that have only used manipulation as a treatment technique for acute pain; therefore, patients with acute pain presented in these investigations have an average initial pain of 5 and, after 2 interventions, an average final pain of 3, obtaining as a basis a reduction in pain of 23 points.

The analgesic effects of the technique have been produced from the first intervention, also presenting improvements in mobility Table II.

Based on eight articles, 64% analyzed the intervention using SMT in chronic pain (18, 36–38), of which four studies have used the SMT technique as the only form of treatment. While the remaining four have combined manipulation with therapeutic exercise (18, 36-38). These studies have managed, with an average of five sessions, to reduce pain by at least 3 points, remembering that the initial pain was at 5 and the final pain at 2.

To study disability, nine studies have been used as a reference. They used the NDI variable to assess disability. They were also divided according to the typology of the pain state, whether acute or chronic. Distributing seven studies on chronic pain and two studies on acute pain.

The disability in the group of studies with acute typology (29, 39–41) initially indicates an average value of 19 points of cervical dysfunction measured with the NDI, and after 4 sessions, this average has decreased to reach 9 points. In chronic pain studies, participants show an average of 19 points of dysfunction. Measured with the NDI prior to the application of the treatment, at the end of the interventions, a decrease of 9 points in disability has been achieved, giving an average response of 11 points in the same questionnaire.

Tabla 2

Clinical trials with SMT on acute and chronic pain

ACUTE PAIN SMT SMT SMT SMT **CHRONIC PAIN** SMT + ET SMT SMT + ET SMT + ET SMT + ET SMT SMT + ET SMT SMT	X X X X	X X X X X X X X	373 X 374 X 375 X 376 X X X 377 X
TOTAL 12	4	8	9

Description: SMT (spinal manipulation), ET (therapeutic exercise).

Based on the analysis carried out in this work, thanks to the bibliographic quality presented by the studies collected, we believe it is necessary to specify that the majority of bibliography usually focuses on the study of pain, disability, and joint function. In the case of this study, the focus has remained on pain and disability, two parameters that are quite related and that were believed to be sufficient for the execution of the analysis.

The effectiveness of SMT at the origin of pain is directly related to the intervention protocol. There are cases in which SMT is used as the only treatment technique or, on the contrary, it is included within a multimodal protocol. The action of this technique on pain and disability depends on the number of sessions in which the intervention is applied according to the origin of the pain.

In the case of pain of radicular origin, to analyze its effectiveness, the use of SMT has been studied as the only intervention technique and as part of multimodal protocols when combined with therapeutic exercise and neural mobilization. When the SMT intervention is executed alone, it presents a reduction of 6 points on the pain scale in 6 treatment sessions (31).

The authors indicated that there was less or equal effectiveness when applying SMT for more than six sessions (5, 20, 21). On the other hand, multimodal protocols that include SMT combined with neural mobilization prove to be more effective since they favor a 5-point reduction in pain. This is achieved through nine interventions (25), while therapeutic exercise combined with SMT with six interventions reduces only three pain points (16, 23).

Regarding disability resulting from pain of radicular origin and determined by the NDI, SMT is more effective when used within the multimodal protocol that combines it with therapeutic exercise, obtaining an improvement of up to 22 points in the NDI (16, 23). On the contrary, using SMT as the only treatment technique reduces the patient's disability by only 12 points on the NDI (26).

In pain of mechanical origin, SMT is used as the only treatment technique (5, 22, 27–30) and as part of protocols that in turn combine it with dry needling and thoracic manipulation (6,32). This research indicates that when SMT is used as the only technique for mechanical pain, it is more effective when applied over a total of 12 sessions. By having a reduction in pain by 4 points (28) and less effectiveness when applied to less than 12 interventions (2, 4, 27, 29, 30).

Multimodal treatment protocols that include SMT demonstrate greater effectiveness in combination with thoracic manipulation, reducing three pain points in just two interventions (32).

Regarding disability due to pain of mechanical origin, as determined by the NDI, SMT is more effective when used within the multimodal protocol that combines with thoracic manipulation. Thus, it improves by up to 17 points in the NDI (32). In contrast, using SMT combined with needling reduces patient disability by only 8 points on the NDI (6).

In pain of non-specific origin, SMT is used as the only treatment technique and also as part of protocols that in turn combine it with myofascial induction (33). The multimodal study has shown that the treatment technique for non-specific pain is more effective when applied in 3 interventions, with a reduction in pain by 3 points (33), and less effective when applied as the only treatment technique (1).

Regarding disability due to pain of non-specific origin, the NDI and SMT are more effective when used within the multimodal protocol that combines them with myofascial induction, thus improving up to 12 points in the NDI (33). On the contrary, by using SMT

as the only treatment technique, we reduced the participants' disability by only 3 points in NDI (1).

Therefore, SMT applied according to the origin of the pain proves to be effective for the neck pain presented by patients. Considered as part of the multimodal protocol, it demonstrates greater effectiveness in radicular pain when combined with neural mobilization with six interventions (25). In pain of mechanical origin, it demonstrates greater effectiveness when combined with dry needling, with eight interventions (6). Finally, in pain of non-specific origin, it demonstrates greater effectiveness when combined with myofascial induction with an application of six interventions (33).

Regarding the effectiveness of SMT on the type of pain, the data found in the studies (29, 39–41) indicate that SMT on acute pain is effective. For example, the author Bronfort (39) commented in his study that he made a comparison between manipulation, NSAIDs, and exercise. Furthermore, the use of SMT as a sole treatment was superior to that of the group that used medications, and even the same group obtained the worst results and ended up using a greater number of analgesics to improve acute neck pain. While the case of exercise turns out to have similar results to those of manipulation. This study obtained efficacy by improving the patients' pain by 3 points in just two sessions using SMT.

The same situation occurred in the study of the author (40), who carried out a treatment based on medication, use of prescribed home exercise, and SMT as individual treatment variables to treat acute pain. Obtaining, as a result, a reduction of 3 points with 3 interventions. The authors (29, 42) carried out a comparison of manipulative techniques. SMT at the cervical level versus manipulation at the thoracic level to improve pain and mobility degrees at the cervical level. To do this, they do one or two sessions, obtaining quite satisfying results in the reduction of acute pain since it decreased by 4 points. Showing the effectiveness of the technique and emphasizing the rapid relief of symptoms with a clearly superior margin compared to a manipulation technique at the dorsal level.

With respect to chronic pain, eight of the articles selected in this review have determined their treatments specifically for this condition. Four studies (2, 34, 35, 42) use SMT in a unique way compared to other types of techniques. Studies such as the author (35), compare SMT with mobilization and stretching of tissues at the cervical level, endorsing the effectiveness of all of them for the management of chronic pain. Demonstrating the effectiveness of SMT by obtaining a 5-point difference between initial and final pain in just 3 sessions. Likewise, the author (36) makes the comparison using myofascial release therapy, with results similar to those of the author (35). In the case of SMT in the author's study (36), a difference of 1 point in chronic pain was obtained in two sessions.

Interventions carried out by the authors (4, 34) claim the effectiveness of SMT to treat chronic pain by obtaining a 2-point reduction in pain in just one intervention. These studies highlight providing much more specific analyzes such as cortisol analysis or stabilometric patterns.

The effectiveness of SMT can be explained thanks to the influence it has on the body's chemical markers, producing pain relief and a certain anti-inflammatory response. Despite this, the mechanisms that produce these effects are not completely established (17). Such is the case of the study (34) that suggests the application of a mechanical force such as that caused by manipulation using high-speed techniques or mobilizations. This initiates a cascade of neurophysiological responses that include the nervous and endocrine systems. Therefore, the hormone cortisol has been proposed as a means of verification as it is an anti-inflammatory hormone regulated by the hypothalamic-pituitary-adrenal axis, which is related to the modulation of nociception and stress-induced analgesia.

The experiment mentions an initial measurement in the saliva of the participants, verifying the initial state of cortisol. Three protocols were executed: the SMT technique, cervical mobilization, and a group that includes the SMT simulation. The results indicate that the SMT technique and mobilization immediately increase cortisol levels after their application in patients who perceive these techniques individually. Resulting in a decrease in pain and also in disability measured with the NDI; therefore, the value of both techniques to generate hypoalgesic effects is shown (34).

The results obtained in the study (4), where they used thoracic manipulation and manipulation at the cervical level to treat chronic pain, allude to the change in biomarkers that are related to nociception. Furthermore, they could explain the similar decrease in pain interventions in the two groups. Regarding the interventions that combine exercise plus SMT (18, 37–39), their results show effectiveness on average in session number 12, and there is a difference in pain of at least 1 point.

The quality of life of patients is clearly affected by limiting their ability to perform ADLs. When pain becomes chronic, the patient may experience physical and emotional effects such as a lack of energy, depression, and limited mobility. SMT combined with therapeutic exercise shows a reduction of up to 3 pain points and 24 on the NDI.

Active therapeutic interventions are more effective than passive therapeutic interventions for the treatment of patients with neck pain (4). Furthermore, among the various interventions for chronic neck pain, therapeutic exercises and muscle reeducation are known to be effective (28). Despite several studies on the effects of therapeutic exercise for neck pain, high-quality evidence on exercise therapy for neck pain is still lacking (35).

4. Conclusion

The studies analyzed in this review focused on SMT being included in multimodal treatment. Depending on the origin of the pain (radicular, mechanical, or non-specific), it will be effective on pain and disability in combination with neural mobilization techniques, myofascial induction, thoracic manipulation, therapeutic exercise, and dry needling, applied together according to the origin of the pain.

Regarding the application of SMT to acute or chronic pain, it proves to be effective as the only technique within multimodal treatment. In chronic pain, it has better results when it is part of a treatment combined with therapeutic exercise. Regarding acute pain, it demonstrates effectiveness when applied as the only treatment technique. However, the heterogeneity of the studies in different types, according to the origin of the pain, requires more randomized clinical trials with a larger sample size. Bias and details on the physiological principles of combining SMT with different techniques to obtain stronger conclusions.

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Conflict of Interests

The authors of this research declare that they have no conflict of interest regarding this research, authorship and publication.

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