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KINESIOTAPING IN DISCOPATHIES AND DEGENERATIVE SPINAL DISEASES: SYSTEMATIC REVIEW

KINESIOTAPING EM DISCOPATIAS E DOENÇAS DEGENERATIVAS DA COLUNA VERTEBRAL: REVISÃO SISTEMÁTICA

KINESIOTAPING EN DISCOPATÍAS Y ENFERMEDADES DEGENERATIVAS DE LA COLUMNA VERTEBRAL: REVISIÓN SISTEMÁTICA

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ABSTRACT

Neuromuscular taping or kinesiotaping is a technique widely used in spinal disorders. However, the scientific evidence of its use in discopathies and degenerative spine pathology is unknown. This study aimed to analyze the published clinical trials on neuromuscular taping in subjects with discopathies and degenerative spinal injuries. For this purpose, a literature search was performed following PRISMA guidelines in the following databases: PubMed, Web of Science (WOS), Scopus, Medline, and Cinahl. In analyzing bias and methodological quality, we used: the PEDro scale, Van Tulder criteria, and risk of bias analysis of the Cochrane Collaboration. A total of 5 articles were included that obtained a mean score of 6.2 on the PEDro scale. There is moderate evidence that, in the short term, neuromuscular taping reduces analgesic consumption and improves the range of motion and muscle strength in the posterior musculature. In addition, there is limited evidence that it can improve quality, while the scientific evidence on the effect of neuromuscular taping on pain is contradictory. The application of neuromuscular taping on discopathies and degenerative processes of the spine should be cautiously undertaken until more conclusive results are obtained, and the long-term effects are assessed. ***Level of evidence I; Systematic review.***

Keywords: Spinal Diseases; Intervertebral Disc Degeneration; Intervertebral Disc Displacement; Athletic Tape.

RESUMO

A bandagem neuromuscular ou kinesiotaping é uma técnica de bandagem amplamente utilizada em distúrbios da coluna vertebral. Entretanto, a evidência científica para seu uso em discopatias e na patologia degenerativa da coluna são desconhecidas. Objetivo: O objetivo deste trabalho foi analisar ensaios clínicos publicados sobre bandagem neuromuscular em sujeitos com discopatias e lesões degenerativas da coluna vertebral. Para este fim, foi realizada uma pesquisa bibliográfica seguindo as diretrizes do PRISMA nas seguintes bases de dados: PubMed, Web of Science (WOS), Scopus, Medline e Cinahl. Na análise de viés e qualidade metodológica, foram utilizados: escala PEDro, critérios de Van Tulder e análise de risco de viés da Colaboração Cochrane. Um total de 5 artigos foi incluído com uma pontuação média de 6,2 na escala PEDro. Há evidências moderadas de que, a curto prazo, a bandagem neuromuscular reduz o consumo de analgésicos, melhora a amplitude de movimento e a força muscular na musculatura posterior. Além disso, há evidências limitadas de que pode melhorar a qualidade, enquanto as evidências científicas sobre o efeito da bandagem neuromuscular na dor são contraditórias. A aplicação da bandagem neuromuscular em discopatias e processos degenerativos da coluna vertebral deve ser feita com cautela até que resultados mais conclusivos sejam obtidos e os efeitos a longo prazo sejam avaliados. ***Nível de evidência I; Revisão sistemática.***

Descritores: *Doenças da Coluna Vertebral; Degeneração do Disco Intervertebral; Deslocamento do Disco Intervertebral; Fita Atlética.*

RESUMEN

El vendaje neuromuscular o kinesiotaping es una técnica de vendaje que se utiliza ampliamente en trastornos raquídeos. Sin embargo, se desconoce la evidencia científica de uso en discopatías y patología degenerativa de la columna. El objetivo de este trabajo consistió en analizar los ensayos clínicos publicados sobre el vendaje neuromuscular en sujetos con discopatías y lesiones degenerativas del raquis. Para ello, se realizó una búsqueda bibliográfica siguiendo las directrices PRISMA en las siguientes bases de datos: PubMed, Web of Science (WOS), Scopus, Medline y Cinahl. En el análisis de sesgo y calidad metodológica se utilizaron: escala PEDro, criterios de Van Tulder y análisis del riesgo de sesgo de la Colaboración Cochrane. Se incluyeron un total de 5 artículos que obtuvieron una puntuación media de 6,2 en la escala PEDro. Existe evidencia moderada de que, a corto plazo, el vendaje neuromuscular reduce el consumo de analgésicos, mejora el rango de movimiento y fuerza muscular en la musculatura posterior. Además, existe evidencia limitada de que puede mejorar la calidad, mientras que la evidencia científica sobre el efecto del vendaje

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neuromuscular en el dolor es contradictoria. La aplicación de vendaje neuromuscular es discopatías y procesos degenerativos del raquis debe realizarse con cautela a la espera de que se obtengan resultados más concluyentes y se valoren los efectos a largo plazo. ***Nivel de evidencia I; Revisión sistemática.***

Descriptores: *Enfermedades de la Columna Vertebral; Degeneración del Disco Intervertebral; Desplazamiento del Disco Intervertebral; Cinta atlética.*

INTRODUCTION

Disc degeneration and associated syndromes severely affect the population's daily life and work environment.[1] In turn, intervertebral disc disease is considered one of the leading causes of pain with a high worldwide prevalence, especially among adults, and its etiology is multifactorial.[2,3] The risk factors for disc disease are age, gender, body mass index (BMI), smoking, diabetes, type of hernia, and level of involvement.[4] The presentation of symptoms is variable depending on the patient and usually includes a combination of generalized pain and weakness in the spine. In addition, there may be severe neurological compression, usually manifested by paresthesias, loss of reflexes and strength.[5]

The spinal segments with the highest incidence of disc disease are lumbar and cervical. At the cervical level, they occur most frequently between C3-C4 and C4-C5.[6] In the lumbar spine, the most frequent levels of affectation are the lower ones (L3-L4).[7] Lumbar disc degeneration is the main cause of low back pain and lumbalgia (85% of cases) in industrialized countries; it is the most prevalent cause of chronic pain, second only to headache.[8]

The conservative option, cell therapy, and surgery are among the different treatment modalities.[9,10] The recommended initial treatment is generally conservative; it usually consists of therapeutic exercise, application of different physical agents in physical therapy, non-steroidal anti-inflammatory drugs (NSAIDs), and injection of analgesics, although in specific cases, the surgical option allows for a quicker return to work.[8]

Neuromuscular Taping (NT) or kinesiotaping was developed in Japan in the 1970s.[11] NT consists of an adhesive elastic bandage that addresses soft tissues and theoretically allows an increase or decrease of muscle tone and improves lymphatic and blood circulation.[12] The NT does not contain drugs, its application is simple and inexpensive, the good empirical results have made it popular, and its clinical use is widespread in different medical specialties.[13]

Although different applications have been described, there is currently little evidence to support the use of NT on muscle function[12,] and there is a discrepancy about the benefits of spinal disorders. Nelson's systematic review[13] found limited evidence about its benefit, both in the short and long term, in chronic low back pain. Saavedra-Hernández et al.[14] conclude that using NT in mechanical neck pain does not improve the effects of other treatment methods, such as neck manipulation, achieving similar results. Another review indicates that NT applied to the spine does not affect hip motion and curvatures.[15] However, a recent review indicates that NT may positively affect pain and disability in patients with chronic low back pain.[16]

In addition, several applications of NT for discopathies and spinal processes are described in the literature,[17-20] but the level of scientific evidence for this application is unknown.

Considering the above, this systematic review aims to analyze the published scientific literature to determine the effects of NT in patients with discopathies and degenerative spinal injuries. In addition, the level of existing scientific evidence on this topic will be determined.

MATERIAL AND METHODS

Search Strategy

The systematic review carried out in this paper was conducted according to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[21] A search was conducted during February 2022 in the PubMed, Web of Science (WoS), Scopus, Medline, and Cinahl databases.

You can see the different search equations in the different databases in Table 1. The references of the included articles were stored and registered manually.

Inclusion criteria were selected for studies that: (i) analyze the effects of NT on patients with disc injuries, spondylosis, or

Table 1. Search equations.

Databases	Search equations
pubMed	("Intervertebral Disc"[Mesh] OR "Intervertebral Disc Degeneration"[Mesh] OR "Intervertebral Disc Displacement"[Mesh] OR "Intervertebral Disc Chemolysis"[Mesh] OR "Spondylosis"[Mesh] OR "Spinal Curvatures"[Mesh] OR "Osteoarthritis, Spine"[Mesh] OR "Spinal Osteochondrosis"[Mesh] OR "Ossification of Posterior Longitudinal Ligament"[Mesh] OR "Spinal Osteophytosis"[Mesh]) AND ("kinesiotap*" OR "taping" OR "kinesio tap*" OR "kinesio-tap*" OR "kinesio-tap*" OR "musculoskeletal tape" OR "kinaesthetic tap*" OR "Athletic Tape"[Mesh] OR "KT" OR "kinesiology tap*" OR "elastic therapeutic tape" OR "neurotape" OR "neuromuscular tape")
WOS	((((((((((TS=(intervertebral disc)) OR TS=(intervertebral disc displacement)) OR TS=(intervertebral disc degeneration)) OR TS=(intervertebral disc chemolysis)) OR TS=(spondylosis)) OR TS=(spinal curvatures)) OR TS=(spinal osteoarthritis)) OR TS=(spinal osteochondrosis)) OR TS=(ossification of posterior longitudinal ligament)) OR TS=(spinal osteophytosis)) AND ((((((((((TS=(kinesiotap*)) OR TS=(kinesio tap*)) OR TS=(kinesio-tap*)) OR TS=(taping)) OR TS=(musculoskeletal tape)) OR TS=(kinaesthetic tap*)) OR TS=(athletics tape)) OR TS=(KT)) OR TS=(kinesiology tap*)) OR TS=(elastic therapeutic tape)) OR TS=(neurotype)) OR TS=(neuromuscular tape))
Scopus	(TITLE-ABS-KEY("kinesiotap*" OR "taping" OR "kinesio tap*" OR "kinesio-tap*" OR "kinesio-tap*" OR "musculoskeletal tape" OR "kinaesthetic tap*" OR "Athletic Tape" OR "KT" OR "kinesiology tap*" OR "elastic therapeutic tape" OR "neurotape" OR "neuromuscular tape")) AND (TITLE-ABS-KEY("intervertebral disc" OR "intervertebral disc displacement" OR "intervertebral disc degeneration" OR "intervertebral disc chemolysis" OR "spondylosis" OR "spinal curvatures" OR "spinal osteoarthritis" OR "spinal osteochondrosis" OR "ossification of posterior longitudinal ligament" OR "spinal osteophytosis"))
Medline	((MH "Intervertebral Disc Degeneration") OR (MH "Intervertebral Disc") OR (MH "Intervertebral Disc Displacement") OR (MH "Intervertebral Disc Chemolysis") OR (MH "Spondylosis") OR (HM "Spinal Osteophytosis") OR (HM "Spinal Curvatures") OR (HM "Spinal Osteochondrosis") OR (HM "Ossification of Posterior Longitudinal Ligament")) OR (MH "Osteoarthritis, Spine")) AND ((MH "Athletic Tape") OR "kinesiotap*" OR "kinesio-tap*" OR "kinesiology tap*" OR "kinesio tap*" OR "musculoskeletal tape" OR "taping" OR "kinaesthethic tap*" OR "KT" OR "elastic therapeutic tape" OR "neuromuscular tape" OR "neurotape"))
CINAHL	((MH "Intervertebral Disk") OR (MH "Intervertebral Disk Displacement") OR (MH "Intervertebral Disk Chemolysis") OR "Intervertebral disc degeneration" OR (MH "Spondylosis") OR (HM "Spinal Curvatures") OR (HM "Osteoarthritis, Spine") OR "Osteochondrosis" OR (HM "Spinal Osteophytosis") OR "Ossification of posterior longitudinal ligament")) AND ((MH "Kinesiotaping") OR "kinesio tap*" OR (MH "Athletic Tape") OR "kinesio-tap*" OR "kinesiotape" OR "kinesiology tap*" OR "musculoskeletal tape" OR "KT" OR "taping OR "kinaesthetic tap*" OR "elastic therapeutic tape" OR "neurotape" OR "neuromuscular tape"))

WOS: Web of Science/ TS: topic/ ABS: abstract/ KEY: keyword/ MH: MeSH (Medical Subject Headings).

degenerative spinal diseases; (ii) include ECA-type studies; (iii) the language of the article is English. Articles that do not fit the study topic are not in English, are repeated, and area reviews, meta-analyses, or different types of studies or protocols are excluded.

Methodological Quality Analysis and Risk of bias assessment

The evaluation of the methodological quality of the included articles was reviewed using the PEDro (*Physiotherapy Evidence Database*) scale.[22,23] On the other hand, the analysis of the risk of bias was performed using the tool "*The Cochrane Collaboration*"[24] and its corresponding graphic representation ("*robvis visualization* tool" available at: https://www.riskofbias.info/welcome/robvis-visualization-tool). Each of the six items in each article is evaluated and identified according to the level of risk they present as "low risk", "high risk" or "unclear risk".[25] Furthermore, the level of evidence of the review will be obtained using the Van Tulder criteria.[26]

RESULTS

The item selection process is summarized by the flow chart in Figure 1.

Five articles were included to meet the objective of this work. The characteristics of the participants are shown in Table 2. Five articles were included to meet the objective of this work.[27-31] between 60[30] to 40[28,29] subjects. During the intervention, losses were registered in three selected studies.[27,28,30] The ECA[27-31] is performed in different age groups, with most of the studies taking adult-age subjects.[27,28,30,31] Although there is an article using the adolescent population.[29] The characteristics of the interventions carried out are presented in Tables 3 and 4.[27-31]

The most frequently analyzed variable is pain, measured in all the studies.[27-31] The second most frequently analyzed variable was the level of disability, which appears in 3 of the studies.[28,30,31] The methodological quality of the five selected studies was evaluated with the PEDro scale, obtaining scores of 4[29,6,27] and 7.[28,30,31.] According to Cashin et al., four of the studies in the review[27,28,30,31] present good methodological quality because they have a PEDro scale score between 6 and 8. In contrast, the Atici et al.[29] study has acceptable methodological quality.

The risk of bias in the studies was analyzed using the Cochrane tool.[24] All the studies provided a low risk of bias in the sections on the generation of the randomized section and concealment of the section. On the other hand, in the blinding investigator section, all the studies reflected a high risk. (Figure 2)

Finally, the level of evidence of the review was determined using the Van Tulder scale.[26] Interpretation of the overall scientific evidence of the included RCTs[27-31] is debatable for the pain variable; *a priori* it could be considered moderate because there are findings that it decreases in a high quality RCT[27] and in a low-quality RCT[29] according PEDro,[23] but it is more appropriate to specify that the evidence is contradictory because the other three articles of good methodological quality that are included[28,30,31] without improvement in this variable. Moderate evidence was also obtained (one RCT of high methodological quality) on the reduction of analgesic consumption,[30] improved ROM and muscle strength.[31] On the other hand, when measuring the quality-of-life variable, limited evidence was obtained by finding consistent results only in one RCT of low methodological quality.[29] Other variables showed no significant results in any of the included RCTs. Among them are balance and kyphosis angle,[27] in addition to disability level,[28,30,31] flexion-relaxation ratio[28] and pain related to myofascial stiffness.[28] It is also noteworthy that one of the articles included in the review presents no evidence of the use of NT in any of the variables it evaluates.[28]

DISCUSSION

This review aimed to evaluate the effects of neuromuscular bandaging in patients with disc disease or degenerative spine processes. In our opinion, this is the first systematic review that addresses this topic. However, the application of NT is very widespread at the clinical level, and NT applications are widespread in different manuals.[17-20]

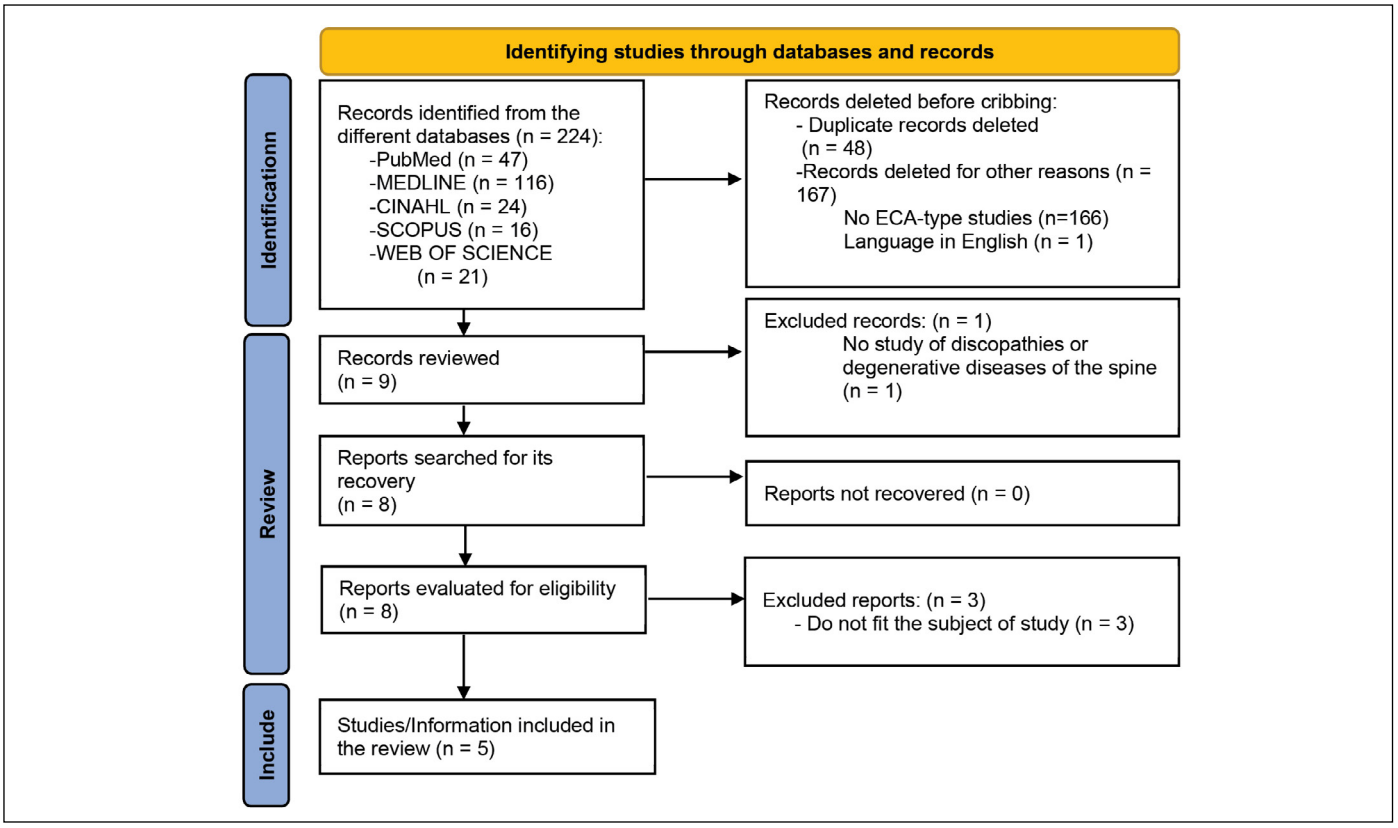

Figure 1. Flow chart.

Table 2. Characteristics of the participants.

Author	Total sample	Losses	Inclusion Criteria	Exclusion Criteria
Bulut et al.[27] (2019)	47 GC: 24 GI: 23	5	Patients diagnosed with osteoporosis Postmenopausal women with thoracic hyperkyphosis	Not mentioned
Grzeskowiak et al.[28] (2019)	40 GC: 20 GI: 20	2	Age between 20 and 55 years Unilateral or central disc herniation was confirmed on MRI at vertebral levels L4/L5 and L5/S1. A score of 4 or more on the Roland-Morris Low Back Pain and Disability Questionnaire (RMDQ) Lumbar or lumbosacral pain of at least three months duration	Disc degenerations or hernias at levels other than those specified in the lumbar spine Coexisting systemic or orthopedic diseases Pregnancy Coexisting pathologies of the vertebral column and pelvis Previous spinal column or pelvis surgery Previous NT therapy No referral to physical therapy at the time of the study BMI > 30
Atici et al.[29] (2017)	40 GC: 20 GI: 20	0	Students from 10 to 18 years old Lenke's diagnosis of AIS type 1 Back pain only in the apical convex edge, lasting more than three months	Lumbar pain Local or systemic regional infection Neoplasia Neurodermatitis Skin diseases such as eczema or psoriasis Decompensated heart failure Pregnancy Asthma in the advanced stage Intervertebral disc disease Previous surgery Anomalies or tumors of the spinal cord Any spinal pathology, such as spondylolysis, spondylolisthesis, or transitional lumbosacral anomalies, could be related to back pain. Not receiving medical and physiotherapeutic treatment in the last year and not using a brace.
Keles et al.[30] (2017)	60 GC: 30 GI: 30	8	Between 18 and 45 years old. Lumbar disc hernia confirmed by MRI. Lumbar pain – a symptom of lumbar disc herniation lasting more than three months Score of 3 or more on the Numerical Pain Rating Scale (NRS)	Severe degenerative disorder with concomitant spinal stenosis confirmed by imaging methods Congenital anomaly of the spinal column Previous or coexisting pathology of the spine History of surgery, trauma, or cancer Inflammatory low back pain Motor weakness or urinary/fecal incontinence caused by disc hernia Caballo's glue syndrome Any other neurological disease Dermatitis/previous skin lesion in the area of NT Previous knowledge of the use of NT Pregnancy
Copurgensli et al.[31] (2017)	45 GC: 15 GIA: 15 GIB:15	0	Between 40 and 60 years old Diagnosis of cervical spondylosis Cervical pain of more than one month and directed in at least one direction A score of 2 or more on the VAS pain scale Not having received treatment in the last six months Do not have any contraindications to moving	Previous history of trauma, fracture, or surgery. Neurological or circulatory disorder Whiplash Psychiatric or psychological conditions

AIS: Adolescent Idiopathic Scoliosis/ VAS: Visual Analog Scale/GC: Group Control/ GI: Intervention Group/ GIA: Intervention Group 1/ GIB: Intervention Group 2/ IMC: Body Mass Index/ RM: Magnetic Resonance Imaging/ NT: Neuromuscular Taping.

The main results of the RCTs included in this review[27-31] indicate that in the short term, a significant improvement is described when using it as an analgesic method. However, no conclusive long-term results were obtained because there are parameters such as kyphosis angle or balance[27] in which no significant differences were observed in the analyzed studies. There were also no changes at the myofascial level or in trunk extension strength.[28] Regarding ROM, there are different results depending on the type of movement to be performed and the area of the spinal column involved.[28,30,31]

Effect of NT on the cervical spine

Only the article by Copurgensli et al.[31] deals with cervical spondylosis, so it is difficult to establish comparisons between the results and the other articles included.

Firstly, significant short-term increases were obtained after applying NT and conventional rehabilitation (CR) only in the cervical ROM and deep cervical flexor muscle strength variables, compared to the exclusive use of CR.[31] In the investigations by Ay et al.[32] and Onat et al.[33] observed a short-term improvement in ROM parameters when comparing the use of NT versus placebo taping or dry puncture in patients with cervical myofascial pain syndrome and chronic neck pain, respectively. However, in other studies[34] conventional massage achieved better results in cervical ROM parameteres. Puerma-Castillo et al.[35] indicate that NT does not improve against CR.

Secondly, the article by Copurgensli et al.[31] did not obtain positive results about using NT in other variables, such as pain or disability index, compared to other treatment modalities, such as Mulligan's mobilization (MM) together with CR or the use of CR exclusively. When trying to contrast this data, there are contradictory results among the different reference articles.[32-36]

On the one hand, the Puerma-Castillo[35] does not observe significant results of the use of NT vs. CR, in the variables of pain and disability index. In the study by El-Gendy[36] positive results are recorded for both variables after one week of intervention, but after six weeks of treatment these improvements are no longer significant. The study by Toprak Celanay et al.[34] shows that the application of NT is beneficial in both variables after 4 weeks of treatment. Furthermore, in the study by Ay et al.[32] changes are observed after the application of NT in the decrease in pain, while the disability index

Table 3. Intervention characteristics.

Author	Duration of the Intervention/ Evaluations	Intervention	Measurement / Instruments
Bulut et al.[27] (2019)	- 6 weeks. -2 daily exercise sessions every day of the week. -1 weekly application of NT. - Evaluations before the beginning, at mid-study (week 3), and the end of the study (week 6)	-GC: home exercise (strengthening, balancing, and stretching) - IMG: exercises at home + NT	-Evaluation with "Kinesthetic Ability Trainer" SportKAT 1700. -Evaluation of PE employing the Berg Balance Scale. -AC utilizing the Smarter Inclinometer Dualer IQ -Spread color: VAS scale (0-10)
Grzeskowiak et al.[28] (2019)	-1 week. -Bands are placed at the beginning. -Pre- and post-evaluation in process time.	-GC: taping with another type of elastic band (Placebotaping) -GI: NT	-Pain intensity: QVAS Scale -FRR y ERR: EMG of paraspinal muscles -Disability level: Roland-Morris Questionaire -Myofascial stiffness pain: pressure pain thresholds using digital FDIX algometry -Strength of back extension: M550
Atici et al[29] (2017)	-4 weeks -3 weekly stretching sessions -1 weekly application of NT. -Evaluation at the beginning and the end of the procedure.	-GC: stretches (3 sets of 4 repetitions of 20 s on the concave side) + NT without tension -GI: stretching (same as in GC) + NT	-Pain: VAS scale -Quality of life: SRS-20 Score based on the SRS-22 questionnaire for the evaluation of spinal column deformity
Keles et al.[30] (2017)	-12 weeks. -NT is applied once a week for the first three weeks, then every three weeks (weeks 1, 2, 3, 6, 9, and 12). -Evaluations before the start and after 3,6,12 weeks of trial. An additional evaluation is performed 30 min after placement of the first NT.	-GC: NT without tension on the painful point + exercise. -GI: NT at a painful point + exercise.	-Pain: numerical pain scale (0-10) -ROM (lumbar flexion): FFD y LST -Analgesics ingested: number of pills -Disability level: HAQ y ODI
Copurgensli et al.[31] (2017)	-3 weeks Five consecutive weekly CR sessions. Two weekly sessions of NT in the GK. Three weekly MM sessions at the GM. -Evaluation at the beginning (T1) and end of treatment (T2); additional evaluation one month after the end of treatment (T3).	-GC: RC, which consists of a heat pack for 15 min, Conventional TENS for 20 min, and exercises (strength, balance, and stretching). -GM: MM (between C2 and C7 and with patient in seated position) + RC -GK: NT + RC	-Pain, ROM, muscle strength, and NDI. The measurement of the intervention is divided into T1 (at the beginning), T2 at the end of the intervention) and T3 (after a month of follow-up).

Table 4. Intervention features.

Author	KT application type	Results
Bulut et al.[27] (2019)	. Corrective Technique in X: With the patient in flexion and the shoulders protruding, the NT is applied at the level of the AAC, where the base of the I-band is taken without stretching, and then applying maximum stretch to the lower limit of the contralateral costal patella; the end of the adhesion is applied without stretching. Another NT I-band was also applied to the opposite shoulder with the same technique to obtain a cross sign. The cross point was adjusted to correspond to the lower third of the medial border of the scapula.	Pain: ↓VAS in both groups after six weeks; in the first three weeks ↓, VAS GI>GC. Balance: EE and EF ↑ in both groups after six weeks; ↑EE at 30 min after placing the NT in GI. AC: no significant changes between groups after six weeks; ↑AC at 30 min after placing the NT in the GI.
Grzeskowiak et al.[28] (2019)	Corrective technique in X: With the patient in bipedestation, 2 NT belts were placed with an I-section from the axillary fold to the major trochanter on the opposite side in the form of a cross, with the midpoint superimposed on the lumbosacral junction. The midpoint was fixed without tension, and the tails of the strips were applied with 15-25% tension.	Disability level: ↓ in both groups. No significant differences between the two groups. Pain: ↓ in both groups. No significant differences between the two groups. FRR, ERR, lumbar myofascial stiffness-related pain, and spinal extension force: no significant changes.
Atici et al[29] (2017)	The I-band muscle technique was used on the paraspinal muscles between D3 and L1. The point of origin is the spinal apophyses from D11 to L3, and the insertion point is the spinal apophyses from D3 to T8. Base grip and 25-50% tension are applied on the convex side (from origin to insertion) and 15-25% on the concave side (from insertion to origin).	Pain: ↓VAS en GI>GC. Quality of life: ↑ en GI>GC.
Keles et al.[30] (2017)	The star technique is used. Four I-bands were applied with the patient in maximum trunk flexion. In the GK, the middle point of the belt that is stretched to the maximum is applied at the most painful point, and the ends of the belt are held without stretching.	Pain: ↓ in both groups, but analgesic consumption ↓ in GI. Level of disability: ↓ HAQ and ODI in both groups, but without significant differences between groups Lumbar flexion: no significant changes in FFD or LST.
Copurgensli et al.[31] (2017)	Muscle technique is applied: NT with 5% tension to reduce pain and strengthen the movement in the upper, middle, and lower trapezius muscles and the paravertebral muscles in the sitting position, with a Y-band and an I-band.	Pain and NDI score: ↓ in all groups ROM: -In EC after ↑ at T2 in all, ↓ at T3 in GC, and ↑ at T3 in GMM and GK. -In the ID, the ↑ en T2 of the GK > GC. -In DR and RI, after ↑ at T2 in all, only ↑ at T3 in GMM and GK. Muscle strength: - ↑ in all groups without significant differences, but in the deep cervical flexor, the ↑ of the T2 force of the GK > (GMM or GC).

AAC: Acromioclavicular joint AC: Kyphosis Angle/ EC: Cervical Extension/ EE: Static Balance/ EF: Functional Balance/ ERR: Extension-Relaxation Ratio/ VAS: Visual Analog Scale/ FFD: Finger-To-Floor Distance/ FRR: Extension-Relaxation Ratio/ GC: Group Control/ ID: Right Inclination/ GI: Intervention Group/ GK: Neuromuscular Bandage Group/ GMM: Mulligan Mobilization Group/ HAQ: Health Assessment Questionnaire/ LST: Lumbar Schober Test/ NDI: Neck Disability Index/ ODI: Oswestry Disability Index/ RD: Right Rotation/ RI: Left Rotation/ ROM: Range Of Motion/ T2: Evaluation After Finishing Treatment/ T3: Additional evaluation after one month of treatment/ NT: Neuromuscular Bandage/ ↓: Significant Decline/ ↑: Significant Increase.

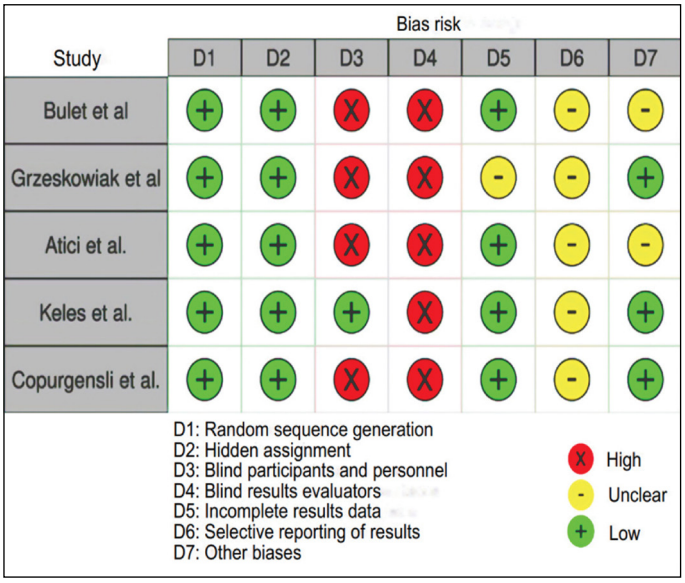

Figure 2. Risk of bias.

variable does not vary. On the contrary, in the study by Onat et al.[33] the changes are significant in the disability index while they are not significant on pain.

Effect of NT on the dorsal root

The ECAs on the dorsal spine[27,29] observe positive short-term changes in pain[27,29] and quality of life[29] after applying NT with exercise[27] or stretching.[29] All this agrees with the data obtained in the research by Mohamed et al.,[37] in which NT achieves positive results in variables such as pain and Cobb angle in women with scoliosis. On the other hand, in the measurement of other parameters such as the kyphosis angle or balance, no differential results are reflected when compared to the use of conventional exercise alone; only with NT is there a one-time improvement compared to the use of exercise alone, and that is in the kyphosis angle at 30 minutes after NT placement. Still, this effect is not maintained over time.[27]

Duangkeaw et al.[38] indicate that the combination of exercise and NT improve children with scoliosis, but the differences with exercise alone are insignificant. Also, Karabay et al.[39] suggest short-term improvements in the kyphosis index after applying NT to children with cerebral palsy. Still, they conclude that NT remains less effective than other treatment modalities.

Another study[40] also concludes that the application of NT and exercise in patients with thoracic hyperkyphosis does not achieve results when compared to using exercise alone on pain and quality of life variables.

Effect of NT on the lumbar spine

Finally, the rest of the included articles focus their studies on lumbar discopathies.[28,30] Both studies compare the application of NT with a placebo,[28] or as a complement to exercise versus conventional exercise.[30] Significant improvements were obtained in pain reduction[28,30] and reducing the number of painkillers ingested.[30]

Celenay and Kaya[41] analyze the immediate effect of NT in patients with chronic lumbar pain, using a band and observing positive short-term changes in pain intensity or postural stability, along with others such as load distribution, can also be observed in studies such as that of Bernardelli et al.,[42] in which elastic bands can maintain their effects up to 10 days.

Other research, such as that of Kelle et al.[43,] states that NT achieves changes in pain intensity and disability index. However, after one month of application, this improvement is only perceived in analgesia as a complement in treating acute nonspecific low back pain.

Also, the study by Köroğlu et al.[44] applies NT as an additional technique in chronic low back pain, together with ultrasound, heat packs, electrotherapy, and exercise. After finishing the intervention at ten days, improvements in the evaluated parameters were obtained, thus increasing the effectiveness of treating chronic low back pain in the short term.

The studies by Kachanathu et al.[45] and Added et al.[46] concur that, in the long term, conventional rehabilitation based on manual therapy or manual therapy plus exercise, respectively, achieves the same benefits in the parameters of pain, muscle strength, elasticity, and range of motion with or without the application of NT.

NT application techniques

If the area of the rachis involved is related to the type of NT application, for the cervical area, the muscle technique with I- and Y-bands was chosen, as shown in the research by Copurgensli et al.[31] To verify this use, the previously mentioned articles by Celenay et al.[34] and El-Gendy et al.[36] have also obtained satisfactory results using the muscle technique in patients with chronic neck pain.

For the dorsal raphe, two studies[27,29] in which different NT application techniques are used are included in the review. The first is the study by Bulut et al.[27] that applies the cross-correction technique to women presenting with thoracic hyperkyphosis without obtaining significant long-term results compared to other treatment modalities. Similar results can be seen in the study by Karabay et al.,[39] in which cross NT does not improve the data obtained by muscle neurostimulation in thoracic hyperkyphosis. Nor have other types of NT applications generated significant changes by combining NT with other treatment models for thoracic hyperkyphosis.[40]

In the second of the articles included in the review, which covers the dorsal spine, NT is applied through muscle technique and combined with stretching in adolescents with scoliosis, obtaining improvements in variables such as pain and quality of life.[29] Contrasting the results with other articles that treat scoliosis with this application, contradictory results were obtained. On the one hand, studies such as Mohamed et al.[37] support the improvement after applying NT, while other studies, such as Duangkeaw et al.,[38] states that these improvements are not significant. Therefore, when approaching this rachis region, there is no predominance of any technique for applying NT.

Finally, between the two studies included in the review that covers the lumbar region,[28,30] there are also differences in the type of application of NT on disc herniations. The study by Grzeskowiak et al.[28] uses the cross-correction technique, while the article by Keles et al.[30] uses the star technique with I-bands.

In contrast to the literature, the corrective cross technique is applied in the study by Celenay and Kaya[41], obtaining significant short-term results in postural stability and pain. On the other hand, the study by Kelle et al.[43] obtained significant results on pain and disability when applying NT using the star technique. In addition, studies such as those by Bernardelli[42] and Koroglu[44] use other NT application techniques and also obtain positive results. Therefore, when contrasting the type of application in the lumbar region with other studies, there is heterogeneity in the types of application, so it is difficult to establish a predominant method, in addition to the fact that the evidence may be questioned since all the studies mentioned above involving the lumbar region observe the benefits of the application of NT only in the short term.[28,30,41-44]

Methodological Quality and Risk of Loss

Concerning the methodological quality of the review, an average score of 6.2 out of 10 possible points was obtained. Therefore, the overall methodological quality of the review is set to moderate--adequate. Other reviews evaluating the effects of NT, such as the one by Alonso Martín et al.[12] and Nelson,[13] obtain similar scores (6.4 and 6.6).

When evaluating the biases exposed by the Cochrane tool,[24] a high risk of performance bias was observed in most studies due to the difficulty in shielding participants and therapists in applying NT. The review by Alonso Martín et al.[12] states that in the studies that

analyze the effect of NT, there is difficulty in demonstrating causality regarding its effects in clinical practice. This may be due to heterogeneity in the parameters when applying the NT.

On the other hand, one of the limitations of the review is the small number of articles included, which makes it difficult to make direct or indirect comparisons between them. Furthermore, conducting studies with more participants is necessary to obtain conclusive results and sufficient scientific evidence. An example of this was that the study with the largest sample size involved a total of 60 participants, of which only 30 subjects received NT.[30]

Another limitation that can be observed is the losses in the sample during the investigation. In the review, three articles present losses in the sample.[27,28,30] On the one hand, during the study by Bulut et al.,[27] there were five losses due to a lack of follow-up or to pathologies that prevented the participants from continuing to participate. In this case, to justify the losses, the authors performed an intention-to-treat analysis; according to Elkins and Moseley,[47] intent--to-treat analysis includes all data from each participant regardless of whether or not he or she receives the assigned intervention and will serve to evaluate the effectiveness of an intervention when applied in daily clinical practice, where factors such as poor adherence may reduce its effect. On the other hand, the studies by Grzeskowiak et al.[28] and Keles et al.[30] did not perform the analysis by intent to treat or did not consider losses in the statistics, which means that the outcome data may be incomplete and that there may thus be a risk of attrition.[25] Another of the limitations that can be highlighted in the studies analyzed is the use of NT only in the short term; for this reason, of all the trials included, the one with the longest duration does not exceed 12 weeks,[30] so it is not known how long the effects achieved may last. It is also necessary to mention about the present work that no systematic review protocol was prepared beforehand, which could be due to the scarce number of studies and reviews related to the subject.

For future research, it will be necessary to define standardized application parameters to demonstrate through scientific evidence the different effects of NT. Furthermore, studies with a longer duration of intervention and without other treatment modalities are needed to determine the specific effect of NT on patients with degenerative spinal cord processes, thus avoiding confounding variables.

Also, in the future, we should study the effects of NT on histological[48] or degenerative[3] changes described in discopathies and associated disorders.

CONCLUSION

In subjects with discopathies and degenerative processes of the spine, there is moderate evidence that, in the short term, NT reduces the consumption of analgesics and improves ROM and muscle strength in the posterior musculature. Furthermore, there is limited evidence that it can improve quality, while the scientific evidence on the effect of NT on pain is contradictory.

According to the included studies, using NT as an adjunct to conventional rehabilitation does not report long-term improvements.

The NT techniques that are applied in subjects with discopathies and degenerative processes are muscle technique (Y and I cut), corrective technique (X placement), and space release technique (star application). However, considering the studies with better methodological quality, no one technique can be preferred.

The application of NT to disorders and degenerative processes of the spinal cord should be carried out with caution while waiting for more conclusive results to be obtained and the long-term effects to be evaluated.

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