BRAIN. Broad Research in Artificial Intelligence and Neuroscience
ISSN: 2068-0473 | e-ISSN: 2067-3957
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2023, Volume 14, Issue 4, pages: 266-291 | https://doi.org/10.18662/brain/14.4/505

The Impact Of HVLA Manipulations and Therapeutic Massage in Increasing the Mobility of the Lateral Flexion of the Neck

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Abstract: *The purpose of this study was to establish if high-velocity, low-amplitude manipulation (HVLA) combined with therapeutic massage can improve cervical spine mobility, particularly neck lateral flexion, on the left and right sides, given that lateral neck flexion is 90 degrees. The sample of 75 participants was comprised of 35 men (46.6%) and 40 women (53.3%), all of whom were between the ages of 20 and 60 and were divided into four groups based on their average ages: 20 to 30 years, 31 to 40 years, 41 to 50 years, and 51 to 60 years. These groups were further subdivided into two groups by gender, male and female. Patients' lateral flexion was measured with a goniometer, which displays the angle of lateral flexion before and after treatment. C1-C7 vertebral level and shoulder joint level HVLA procedures were conducted. The therapeutic massage concentrated on the trapezius, sternocleidomastoid, platysma, splenius, and semispinalis muscles using relaxing techniques. Each patient's left and right elbow lateral flexion was measured with a goniometer following HVLA manipulations and therapeutic massage to see whether or not there was a significant increase. After combining the findings and measurements, we were able to determine that these combined methods increase the cervical spine joint mobility of the 75 participants by a mean of 12.36 degrees.*

Keywords: *high-velocities low-amplitude, HVLA, therapeutic massage, muscles, neck, spine joint.*

How to cite: Muntean, R.-I., Ştefănică, V., Ursu, V. E., Rusu, R. G., Man, C. M., Tomuş, A. M., Fleancu, J. L., Radu, P. O., Neamţu-Popescu, A., & Roşu, D. (2023). The impact of HVLA manipulations and therapeutic massage in increasing the mobility of the lateral flexion of the neck. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 14*(4), 266-291. https://doi.org/10.18662/brain/14.4/505

Introduction

The prevalence of neck pain and limited range of motion is notably high. The prevalence of this condition in adults ranges from 15.4% to 45.3% during a one-month period, and from 12.1% to 71.5% over a twelve-month period (Patrick & Chou, 1976; Hogg-Johnson et al., 2008). Neck pain, despite its considerable prevalence, often transitions into a chronic condition, impacting approximately 10% of males and 17% of females (Bovim et al., 1994). As a result, neck discomfort has been identified as a significant cause of disability, necessitating considerable allocation of healthcare resources and treatment interventions (Bokarius & Bokarius, 2010).

Manipulation, as an ancient technology, can be traced back to parallel developments throughout several regions throughout history (Cyriax & Schiotz, 1975).

Manipulation therapy, a form of physical therapy, is widely done by healthcare practitioners across several professions, including osteopathy, chiropractic, and physiotherapy, for the purpose of addressing musculoskeletal pain and impairment (Rubinstein et al., 2011).

The therapy employs non-pharmaceutical and non-invasive methods to alleviate joint pressure, boost joint mobility, restore muscular and tissue equilibrium, facilitate the movement of bodily fluids, mitigate inflammation, and augment nerve functionality (Di Fabio, 1992). Ongoing scientific study is being conducted on this technique, which has yielded several good clinical outcomes thus far. Nevertheless, the theoretical foundation to substantiate all facets of its therapeutic application remains insufficiently established (Evans, 2010).

The absence of a comprehensive definition for manipulation can be attributed to its colloquial usage. The ambiguity of the word has posed a significant challenge for numerous authors in their attempts to differentiate between genuine manipulation and its counterparts in physical therapy (Song et al., 2006). Numerous scholars have endeavored to provide a credible and comprehensive definition through various scholarly works, although a definitive consensus on the matter remains elusive. Furthermore, it is important to note that the definition of the concept in question may differ among different areas of specialization (Maigne & Vautravers, 2003). In the field of osteopathy, manipulation is not perceived as a comprehensive therapeutic approach, but rather as an integral component of the manipulative therapy plan tailored to a specific patient (Wieting & Cugali, 2005). Furthermore, it is important to note that manipulation therapy and mobilization differ in their approach. Theoretically, manipulation therapy does not permit the recipient to halt joint movement throughout the procedure. On the other hand, mobilization techniques involve the application of non-thrust passive motion to the spine, which can be resisted by the recipient (Maricar et al., 2009).

Chiropractic spinal manipulations can be characterized as mechanical occurrences. Clinicians apply a controlled force of a defined magnitude to a designated target spot, commonly located on the spine. Chiropractors commonly employ high-velocity, low-amplitude (HVLA) manipulations more often than other therapeutic approaches. These manipulations are particularly noteworthy due to their utilization of high force magnitudes and rapid force application rates. High-velocity, low-amplitude (HVLA) treatments have been found to induce spinal deformations and affect the surrounding soft tissues. Additionally, these treatments frequently result in the production of a cracking sound, which has been attributed to the cavitation of spinal facet joints (Cascioli et al., 2003).

According to the referenced study, doctors generally employ significantly lower levels of force when administering therapies to the cervical spine in comparison to the thoracic spine (Herzog et al., 1993).

High-velocity, low-amplitude thrusting techniques (HVLA) are commonly employed by osteopaths (Gibbons & Tehan, 2006).

The Adams et al. study was the pioneering effort to quantitatively measure the forces applied by chiropractors during spinal manipulation. The researchers applied a high-velocity low-amplitude (HVLA) manipulation push to a treatment dummy as part of their study. Despite being a renowned piece of literature, the authors' study had a notable drawback in that it did not involve experimentation on human participants. Consequently, this raises concerns about the applicability of the findings in a clinical context (Adams, 1984). In 1990, Haas conducted the pioneering study that involved the direct measurement of pressures exerted by chiropractors on human volunteers across various treatment techniques (Haas, 1990). A thin and flexible pressure pad was employed by the researchers to gauge the magnitude of forces exerted by the clinician's thrusting hand onto the designated area of patients. Subsequent to this groundbreaking research, a sequence of comparable investigations ensued, with the primary objective of acquiring data pertaining to the force-time profiles associated with high-velocity, low-amplitude (HVLA) spinal manipulations (Mootz et al., 2000).

The act of manipulating the joints is commonly linked to the production of an audible phenomenon characterized by a distinct "clicking" or "popping" sound. The auditory manifestation is believed to be the result of a phenomena referred to as cavitation, which takes place inside the synovial fluid present in the joint. When a manipulation is executed, the force that is imparted causes a separation between the articular surfaces of a synovial joint that is completely enclosed. The deformation of the joint capsule and intra-articular tissues leads to a subsequent reduction in pressure within the joint cavity (Brodeur, 1995).

The phenomenon of cavitation or the production of cracking sounds is frequently observed during the process of manipulation or adjustment (Sandoz, 1976). According to existing beliefs, the production of cavitation sounds occurs when the articular surfaces of a joint undergo a significant separation during the process of an adjustment (Roston & Haines, 1947). After the occurrence of cavitation in the metacarpophalangeal joint, there is a modest expansion of the joint space (Unsworth et al., 1971).

In brief, the understanding of stress and strain transmission across hard and soft tissues during spinal manipulation remains limited. The subject under consideration is a broad area of study that requires meticulous examination in order to comprehend the intricate mechanisms of HVLA therapies and ascertain potential dangers associated with these procedures (Herzog, 2010).

After conducting a comprehensive review of multiple definitions and establishing a shared terminology, Crawford put forth the subsequent definition: "The methodical manipulation of soft tissues using manual techniques that exerts a beneficial influence on healing processes, mitigates stress, enhances muscular relaxation, improves local blood flow, and fosters a state of overall well-being."

Massage therapy (MT) has been found to alleviate discomfort. While commonly categorized as a subset of complementary and integrative medicine, its utilization is progressively expanding within allied health disciplines, including physical and occupational therapy. There has been a noticeable rise in the demand for alternative and integrative medicine, with a specific focus on massage therapy. This growing interest has resulted in an increased number of individuals seeking this type of treatment over time (Crawford et al., 2016).

Massage therapy (MT), an ancient and rudimentary method for alleviating pain, has been extensively employed for the treatment of neck pain. Therapeutic manipulation, either manual or mechanical, is characterized by the application of various particular and general procedures in a sequential manner, including effleurage, petrissage, and percussion (Imanura et al., 2012). Nevertheless, there exists a lack of consensus about the varying results drawn on the impact of manual therapy (MT) in relation to neck discomfort. Certain previous studies have asserted that there exists inconclusive data about the effects of manual therapy (MT) on neck pain (Haraldsson et al., 2006). Conversely, alternative studies have indicated that MT may yield immediate effects in alleviating neck pain (Brosseau et al., 2012).

Methods

This study was undertaken and carried out over a period of one year (2021-2022) in the private osteopathy, therapeutic massage and medical rehabilitation clinic. We decided to demonstrate that the combination of HVLA manipulations and therapeutic massage can bring considerable changes in the pain and mobility of the cervical spine (C1-C7), and more specifically in the lateral flexion of the neck, based on our extensive experience in medical rehabilitation, through a session of 30 minutes, 10 minutes HVLA manipulation techniques and 20 minutes therapeutic massage. The goniometer being the instrument for measuring the lateral flexion of the neck. A goniometer is used in occupational therapy and sports training to measure the range of motion of the limbs and joints (in us the neck joint). These metrics allow for reliable tracking of a rehabilitation program's success. When a patient has a limited range of motion, a therapist evaluates the joint prior to executing an intervention and continues to use the instrument to track progress. At any joint, the therapist can make these motion measurements.

Subject eligibility criteria

In order to be included in the study, patients had to meet the following criteria:

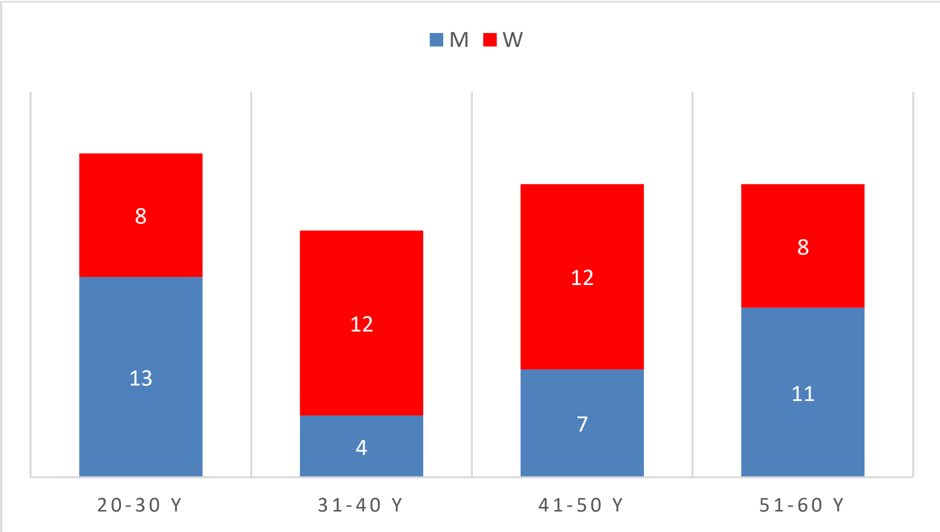
- Age between 20 and 60 years
- Their consent to participate in measurements and treatment

Patient exclusion criteria:

- Osteoporosis
- Ankylosing spondylitis
- Refusal of measurements and treatment
- Age less than 20 years

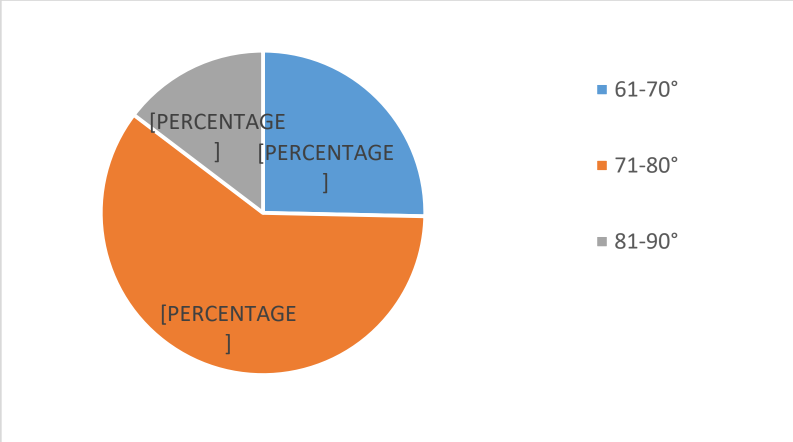
This year, we measured and collected data on 75 participants, 40 women (53.3%) and 35 men (46.6%), aged between 20 and 60, who were divided into 4 media of age respectively 20-30 years, 31-40 years, 41-50 years, 51-60 years, and in turn these groups are each divided into 2 subgroups by gender, male and female (Figure 1), which were complaining of pain and decreased mobility in the cervical region during lateral flexion. This component causing discomfort during the day and during sleep.

Figure 1 Groups divided by age and gender
Authors own conception



According to the initial degree of lateral flexion of the neck, the patients were also divided into three groups: 60-70 degrees (19 patients, 25%), 71-80 degrees (45 patients, 60%), and 81-90 degrees. (11 patients, 15%). Noting that most individuals showed lateral flexion between 71 and 80 degrees, followed by 60 to 70 degrees and then 81 to 90 degrees. (Figure 2)

Figure 2 Groups divided by lateral flexion
Authors own conception



Before starting treatment, the goniometer was used to determine the initial lateral flexion angle of each patient who presented to the office with one of the problems mentioned above (Tabel 1).

Tabel 1 Patients right and left lateral flexion
Authors own conception

Patient	Sex	Right Lateral Flexion	Left Lateral Flexion
1	M	73	72
2	F	85	85
3	M	69	73
4	F	67	65
5	F	77	76
6	M	82	80
7	F	71	73
8	M	65	70
9	M	75	74
10	F	76	76
>75	M	73	74

After establishing the lateral flexion angle, the therapist manipulated the intervertebral joints of the cervical region, the shoulder joint with HVLA techniques and used the Y-Strap, a decompression tool used to stretch the patient's back and release pressure from the vertebrae along the spine vertebral from top to bottom (y-strap.com).

Depending on the condition of each patient, the therapist used the following manipulation techniques: TNJ Supine Close, C1 Sitting Monkey, Cervical Supine Close, C7-T1 Supine Close, C1 Supine , Cervical Spine Side Open, C7-T1 Prone, C7-T1 Side , Shoulder and Mid Ribs Close, AC Joint, Glenohumeral Joint Sitting, First Rib Sitting, Shoulder Combo, Y-axial Distraction with Y-Strap.

After finishing the manipulations, the patients received a therapeutic massage that focused on the neck and shoulder muscles (trapezius, sternocleidomastoid, platysma, splenius and semispinalis) using relaxing techniques (Deep Tissue) and muscle relaxation to improve their mobility and elasticity.

Following these therapeutic procedures, the lateral flexion angle of the individuals was remeasured using a goniometer to see if mobility, lateral flexion of the neck, improved (Tabel 2).

Tabel 2 Patients lateral flexion after treatment
Authors own conception

Patient	Sex	Right Lateral Flexion	Left Lateral Flexion
1	M	86	85
2	F	88	89
3	M	84	85
4	F	80	81
5	F	88	87
6	M	90	87
7	F	86	88
8	M	81	86
9	M	87	87
10	F	88	88
>75	M	87	87

With the help of Microsoft Excel algorithms, we were able to identify the degree of increase in lateral flexion for each patient after centralizing the measurements.

Results

Overall Efficacy of Treatment Techniques:

Through the implementation of specific manipulative and therapeutic massage techniques, we observed a notable enhancement in cervical spine lateral flexion across our participant cohort. Depending on the initial lateral flexion angle, post-intervention enhancements ranged from 3 degrees to as much as 23 degrees (Tabel 3).

Table 3 *Avarage before treatment*
Authors own conception

Patient	Sex	Right Lateral Flexion	Left Lateral Flexion	Average
1	M	13	13	13
2	F	3	4	3.5
3	M	15	12	13.5
4	F	13	16	14.5
5	F	11	11	11
6	M	8	7	7.5
7	F	15	15	15
8	M	16	16	16
9	M	12	13	12.5
10	F	12	12	12
>75	M	14	13	13.5

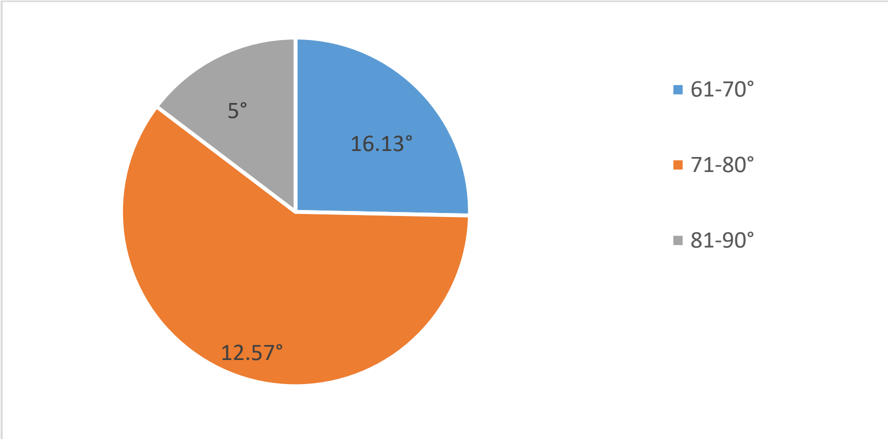
Analysis by Initial Flexion Angle:

Participants with an initial lateral flexion ranging between 60 and 70 degrees evidenced the most substantial improvement, with an average increase of 16.13 degrees in their flexion angle.

The subsequent group, with an initial flexion between 71 and 80 degrees, demonstrated a commendable increase of 12.57 degrees post-intervention.

Interestingly, those with an initial flexion between 81 and 90 degrees manifested a more restrained improvement of 5 degrees (Figure 3).

Figure 3 Analysis by Initial Flexion Angle
Authors own conception



Analysis by Age Cohorts:

Upon segregating the data by age demographics:

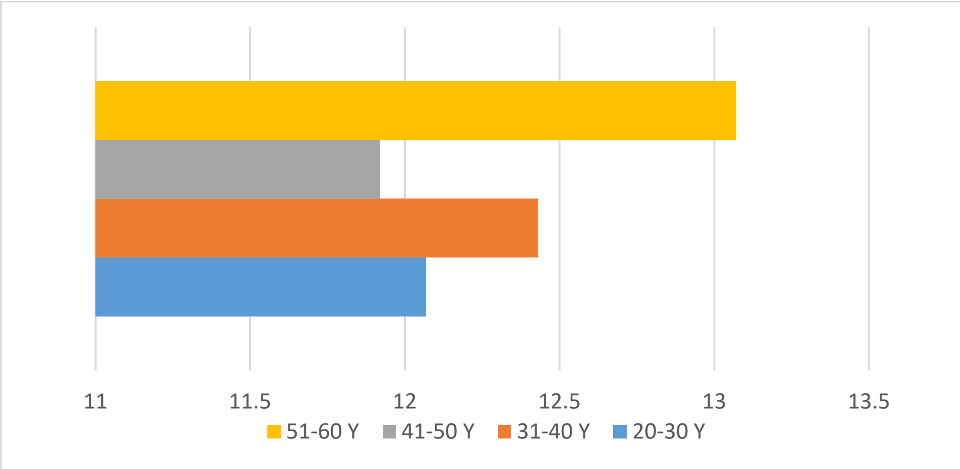
The age group 51-60 years exhibited the most pronounced increase of 13.07 degrees in their lateral flexion.

The 31-40 years age bracket followed closely with an average increase of 12.43 degrees.

Those between 20-30 years saw their flexibility enhanced by 12.07 degrees.

Lastly, the 41-50 years group registered an increase of 11.92 degrees (Figure 4).

Figure 4 *Analysis by Age Cohorts*
Authors own conception

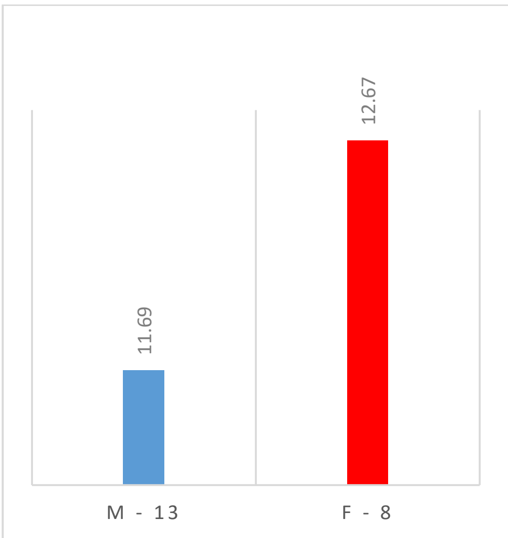


Gender-based Disparities within Age Cohorts:

Utilizing Microsoft Excel for data analyses, distinct patterns emerged when examining gender disparities within specific age groups:

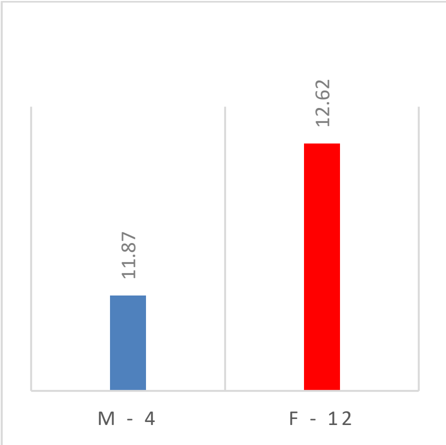
1. 20-30 years cohort: With a composition of 13 men and 8 women, females demonstrated a 1-degree superior enhancement in cervical lateral flexion compared to their male counterparts (Figure 5).

Figure 5 *20-30 years cohort*
Authors own conception



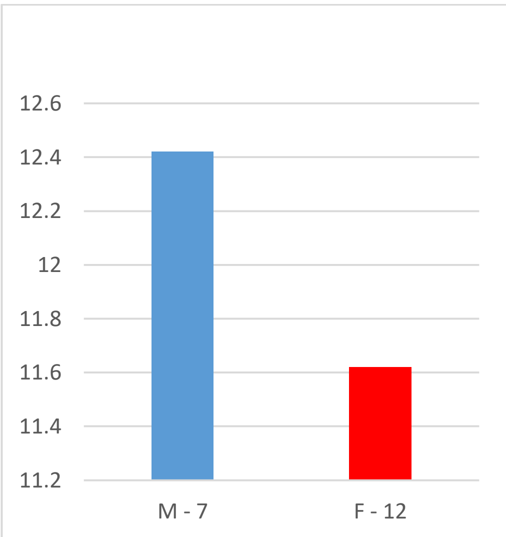
2. 31-40 years cohort: Consisting of 4 men and 12 women, a consistent pattern was observed wherein females outperformed males, showing a greater increase in lateral flexion by approximately 0.8 degrees (Figure 6)

Figure 6 *31-40 years cohort*
Authors own conception



3. 41-50 years cohort: This group, made up of 7 men and 12 women, deviated from the prior trend. Here, male participants outstripped females, showing a 1.2 degrees higher improvement in lateral flexion (Figure 7).

Figure 7 *41-50 years cohort*
Authors own conception



4. 51-60 years cohort: In alignment with the initial cohorts, this group (comprising 11 men and 8 women) again saw females taking the lead, with a 1.4-degree higher enhancement in cervical flexion compared to males (Figure 8).

Figure 8 *51-60 years cohort*
Authors own conception

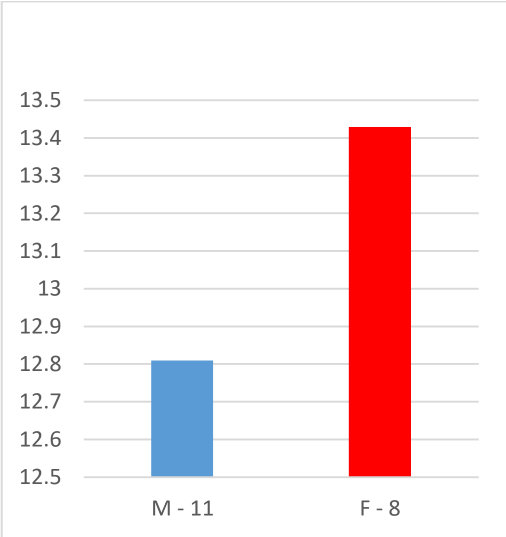


Table 4 *Correlation in SPSS*
Authors own conception

Correlations

		Right Flexion Before	Left Flexion Before	After HVLA/Massage Right	After HVLA/Massage Left	Difference Right	Difference Left	Average Difference	Years	NDI Before	NDI After
Right Flexion Before	Pearson Correlation	1	.887**	.669**	.501**	-.904**	-.822**	-.889**	-.215	-.375**	-.213
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.065	.001	.066
	N	75	75	75	75	75	75	75	75	75	75
Left Flexion Before	Pearson Correlation	.887**	1	.565**	.599**	-.819**	-.908**	-.887**	-.136	-.366**	-.271*
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.246	.001	.019
	N	75	75	75	75	75	75	75	75	75	75
After HVLA/Massage Right	Pearson Correlation	.669**	.565**	1	.754**	-.288*	-.295*	-.300**	-.281*	-.226	-.009
	Sig. (2-tailed)	.000	.000		.000	.012	.010	.009	.015	.051	.941
	N	75	75	75	75	75	75	75	75	75	75
After HVLA/Massage	Pearson Correlation	.501**	.599**	.754**	1	-.212	-.208	-.216	-.174	-.207	-.051

Left	Sig. (2-tailed)	.000	.000	.000		.068	.074	.063	.136	.075	.664
	N	75	75	75	75	75	75	75	75	75	75
Difference Right	Pearson Correlation	-.904**	-.819**	-.288*	-.212	1	.889**	.974**	.115	.353**	.270*
	Sig. (2-tailed)	.000	.000	.012	.068		.000	.000	.325	.002	.019
	N	75	75	75	75	75	75	75	75	75	75
Difference Left	Pearson Correlation	-.822**	-.908**	-.295*	-.208	.889**	1	.970**	.075	.339**	.304**
	Sig. (2-tailed)	.000	.000	.010	.074	.000		.000	.525	.003	.008
	N	75	75	75	75	75	75	75	75	75	75
Average Difference	Pearson Correlation	-.889**	-.887**	-.300**	-.216	.974**	.970**	1	.098	.356**	.294*
	Sig. (2-tailed)	.000	.000	.009	.063	.000	.000		.401	.002	.010
	N	75	75	75	75	75	75	75	75	75	75
Years	Pearson Correlation	-.215	-.136	-.281*	-.174	.115	.075	.098	1	.166	.133
	Sig. (2-tailed)	.065	.246	.015	.136	.325	.525	.401		.155	.254
	N	75	75	75	75	75	75	75	75	75	75
NDI Before	Pearson Correlation	-.375**	-.366**	-.226	-.207	.353**	.339**	.356**	.166	1	.563**

	Sig. (2-tailed)	.001	.001	.051	.075	.002	.003	.002	.155		.000
	N	75	75	75	75	75	75	75	75	75	75
NDI After	Pearson Correlation	-.213	-.271*	-.009	-.051	.270*	.304**	.294*	.133	.563**	1
	Sig. (2-tailed)	.066	.019	.941	.664	.019	.008	.010	.254	.000	
	N	75	75	75	75	75	75	75	75	75	75

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Interpretation of SPSS Correlation Results:

1. Right Flexion Before and Other Variables:

There is a very strong, positive correlation with Left Flexion Before ($r=.887,p<.01r=.887,p<.01$).

It also moderately correlates with After HVLA/Massage Right ($r=.669,p<.01r=.669,p<.01$) and weakly with After HVLA/Massage Left ($r=.501,p<.01r=.501,p<.01$).

There are strong negative correlations with Difference Right ($r=-.904,p<.01r=-.904,p<.01$), Difference Left ($r=-.822,p<.01r=-.822,p<.01$), and Average Difference ($r=-.889,p<.01r=-.889,p<.01$).

A weak negative correlation exists with NDI Before ($r=-.375,p<.01r=-.375,p<.01$).

2. Left Flexion Before:

Demonstrates a moderate positive correlation with After HVLA/Massage Right ($r=.565,p<.01r=.565,p<.01$) and After HVLA/Massage Left ($r=.599,p<.01r=.599,p<.01$).

Strong negative correlations with Difference Right ($r=-.819,p<.01r=-.819,p<.01$), Difference Left ($r=-.908,p<.01r=-.908,p<.01$), and Average Difference ($r=-.887,p<.01r=-.887,p<.01$).

A weak negative correlation is observed with NDI Before ($r=-.366,p<.01r=-.366,p<.01$) and a significant correlation with NDI After ($r=-.271,p<.05r=-.271,p<.05$).

3. After HVLA/Massage Right:

Shows a strong positive correlation with After HVLA/Massage Left ($r=.754,p<.01r=.754,p<.01$).

There are weak negative correlations with Difference Right and Difference Left ($r=-.288r=-.288$ and $r=-.295r=-.295$ respectively, both significant at $p<.05p<.05$).

4. After HVLA/Massage Left:

Has a weak negative relationship with Difference Right and Difference Left but they aren't statistically significant.

5. Difference Right:

Displays a very strong positive correlation with Average Difference ($r=.974,p<.01r=.974,p<.01$) and a strong one with Difference Left ($r=.889,p<.01r=.889,p<.01$).

It also moderately correlates with NDI Before in a positive direction ($r=.353,p<.01r=.353,p<.01$).

6. Difference Left:

Has a very strong positive correlation with Average Difference (r=.970,p<.01r=.970,p<.01).

A moderate positive correlation exists with NDI Before (r=.339,p<.01r=.339,p<.01) and NDI After (r=.304,p<.01r=.304,p<.01).

7. Average Difference:

Moderately correlates positively with NDI Before (r=.356,p<.01r=.356,p<.01) and NDI After (r=.294,p<.05r=.294,p<.05).

8. Years:

Displays a weak negative correlation with After HVLA/Massage Right (r=−.281,p<.05r=−.281,p<.05).

9. NDI Before:

Shows a strong positive correlation with NDI After (r=.563,p<.01r=.563,p<.01)(Table 4).

Discussions

This is the first study to our knowledge that measures the lateral flexion of the neck and establishes the efficacy of HVLA manipulation and therapeutic massage. The findings of this study indicate that a single session of HVLA pulse manipulation combined with therapeutic massage results in better improvements in disability, discomfort, cervical joint, and deep cervical flexor motor performance.

The findings underscore the potential therapeutic benefits of HVLA manipulations combined with therapeutic massage in enhancing cervical spine mobility. It's evident that the starting point of lateral flexion plays a determinant role in the outcomes. Individuals with a lower initial range of motion (60-70 degrees) stand to gain the most from this intervention.

Moreover, intriguing age and gender dynamics emerge from the data. While older individuals (51-60 years) reaped the most benefits, interesting gender discrepancies were observed across different age groups. This opens avenues for further investigation into the underlying physiological or anatomical reasons that might account for these gender-specific differences in therapeutic outcomes.

Future studies might delve deeper into these age and gender dynamics, potentially exploring hormonal or structural variances that could influence the therapeutic response. Furthermore, a longitudinal approach, observing the sustainability of these improvements over extended periods, would provide additional insights into the long-term efficacy of the combined therapeutic approach.

The findings of this study suggest that spine manipulation therapies elicit vertebral joint strains that are notably less in magnitude compared to those induced by routine, daily movements, hence suggesting a lack of harm. Nevertheless, conventional anatomical considerations may not always yield accurate predictions regarding the direction of deformation in specific portions of the spinal joint. An inexplicable phenomenon has been seen, which now lacks a comprehensive explanation. However, it is plausible that this occurrence is linked to the intricate interplay of motions between the vertebral bodies and the intricate stabilization mechanism at the transverse foramen of C1-C7.

The calculated mean of the angles achieved following the procedures was 12.36 degrees for the total group of seventy-five individuals. If we separate the subjects by sex, on average the lateral flexion angle increased by 12.21 degrees in 35 male subjects (46.6%) and by 12.5 degrees in 40 female subjects (53.3%). The difference of 0.29 degrees between genders leads to the conclusion that gender has no influence on HVLA manipulations and therapeutic massage for increasing neck lateral flexion.

The differences are also very small between the age groups, we cannot say that this treatment only helps at an average age, the study shows that for the average age of 20-30 years the average is 12.07 degrees, for 31-40 years it is 12.43 degrees, at 41-50 years being 11.92 degrees, and at 51-60 years being 13.07 degrees. Since we can deduce that this treatment can increase joint mobility, specifically the lateral flexion of the neck at any age.

Gibbons mentioned that following HVLA manipulations, patients may complain of adverse reactions, such as migraines, headaches, joint pains, dizziness, nausea. We would like to specify that none of the 75 patients experienced any adverse reaction following this combined treatment session (Gibbons & Tehan, 2006).

Given the assumption that therapeutic massage and manipulations are both immediately beneficial and safe, it may be advisable to consider these modalities as a pre-emptive supplementary and alternative treatment for those experiencing neck pain and restricted mobility.

The current study found that patients suffering from mechanical neck pain exhibited greater improvements in pain reduction, reduction in disability, increase in passive lateral flexion range of motion of the neck, and enhancement in motor performance of the deep cervical flexor muscles when treated with a combination of cervical and upper thoracic HVLA impulse manipulation and therapeutic massage. Further investigation is warranted to examine the effectiveness of different modalities and doses of manual therapy, as well as to gather extended post-treatment data.

The high-velocity low-amplitude (HVLA) manipulation technique shown superior effectiveness compared to cervical collar and traction exercises (CCF) in enhancing range of motion (ROM) and reducing visual analog scale (VAS) scores during ROM. No significant changes in electromyography (EMG) were observed as a result of any of the therapies (Galindez- Ibarbengoetxea et al., 2017).

There is substantial clinical data supporting the efficacy of manipulation therapy in the treatment of both acute and chronic low back pain (Juni et al., 2009). Nevertheless, the underlying mechanism responsible for these therapeutic outcomes remains partially comprehended. Numerous hypotheses have been postulated by researchers regarding the potential physiological mechanisms behind manipulation. However, the existing scientific data in support of these theories remains constrained.

The theory of joint gapping holds substantial significance in comprehending the underlying process of joint manipulation. There exists a hypothesis suggesting that the separation of the facet joint in the spine promotes the liberation of the imprisoned meniscoid (Evans, 2002), which is a process involving the filling of vacant spaces and the compensation for the incongruity of articular surfaces (Kos et al., 2002).

Throughout the course of history, there has been a widely accepted concept that individuals practicing traditional medicine possessed the ability to realign bones by manipulating the joints. This was also perhaps the underlying factor that led to the designation of manual practitioners as 'bonesetters' (Bigos et al., 1994). According to Evans (2002), the concept of audible cracking sound creation and quick symptomatic alleviation resulting from manipulation may have contributed to its inception. Nevertheless, it has been determined that the origin of the audible 'crack' sound is attributed to a phenomena known as cavitation (Evans, 2010).

Maigne and Guillon employed accelerometers in their study to illustrate that manipulation has the capability to induce temporary yet noteworthy alterations in intradiscal pressure (Maigne & Guillon, 2000).

There has been considerable scholarly discourse surrounding the extent to which the physiological effects of manipulation can be attributed solely to the placebo effect or extend beyond it. Despite the persistent skepticism among skeptics regarding the efficacy of manipulation therapy, a substantial body of research has consistently shown a distinct hypoalgesic impact that is statistically significant when compared to placebo (Thomson et al., 2009). Furthermore, the biomechanical impacts of manipulation have garnered significant acceptance in a substantial body of scholarly research (Herzog, 2010).

In a broad sense, manipulation has been deemed a safe therapeutic approach for addressing musculoskeletal disorders, provided that it is executed with precision and adherence to proper protocols. The main negative concerns encompass transient worsening of symptoms or the emergence of new localized symptoms. The occurrence of severe consequences resulting from manipulation procedures is hardly documented in existing literature (Puentedura et al., 2012). Nevertheless, it has been shown that cervical spine manipulation is linked to many significant dangers, such as stroke, vascular accidents, and non-vascular complications (Ernst, 2007). Consequently, numerous researchers have voiced skepticism regarding the safety of this method and have remarked that the potential hazards linked to the treatments could outweigh the advantages (Ernst, 2007). The discourse surrounding the safety of cervical spine manipulation is a longstanding topic of discussion. The issue of safety has been a matter of worry ever since the initial occurrence of an unfavorable incident, as documented in 1907 (Rivett, 2006). Despite originating from epidemiological reasoning, there has been limited consensus regarding the incidence reporting of adverse events (Puentedura et al., 2012). The stated estimates of the risk exhibit a range from 1 in 50,000 to 1 in 5.85 million (Magarey et al., 2004). The available data strongly indicate that the potential hazards linked to upper spinal manipulation are minimal, given the substantial number of cervical manipulations conducted without any negative consequences.

Conclusion

Right and Left Flexion Before are strongly positively correlated, suggesting that participants with higher right flexion initially tend to have higher left flexion too.

Both right and left initial flexions negatively correlate with the differences (post- minus pre-values), indicating that the higher the initial value, the greater the improvement after the HVLA/massage.

The post-treatment values (After HVLA/Massage Right/Left) are positively correlated, indicating that individuals who showed improvement on one side typically showed improvement on the other side as well.

The Neck Disability Index (NDI) scores before and after treatment are also positively correlated, suggesting that patients with higher disability scores before treatment typically had higher scores after treatment, although this doesn't imply causality.

Some correlations, like those with 'Years,' are not statistically significant, meaning the observed relationships could be due to chance.

The results provide insights into the relationships between initial conditions, treatment outcomes, and potential predictors of treatment response (like NDI scores). Further analysis and studies could explore causal relationships and the clinical implications of these findings.

Ethics approval and consent to participate

The present investigation, which involved human volunteers, adhered to the ethical principles outlined in the Declaration of Helsinki and received approval from the University "1 Decembrie 1918" of Alba Iulia. Prior to registration, all participants were provided with comprehensive information regarding the study's objectives, methodologies, potential hazards, and advantages. All individual subjects included in the study provided written informed permission.

All methodologies were executed in adherence to the pertinent norms and legislation.

All the patients gave their Informed consent to participate in this study, in the private osteopathy and therapeutic massage office.

The University Professional Ethics and Deontology Commission within the "1 Decembrie 1918" University in Alba Iulia noted the following:

- the authors requested the consent of the subjects involved in the research before carrying out any procedures;
- the authors have evidence regarding the freely expressed consent of the subjects regarding their participation in the study;
- the authors take responsibility for observing the ethical norms in scientific research, according to the legislation and regulations in force.

Consent for publication

Not applicable

Availability of data and materials

The authors affirm that the data substantiating the conclusions of this study may be found in the journal itself and its Supplementary material. The primary researcher can provide the raw data supporting the study's findings upon a fair request.

Competing interests

The authors of this manuscript declare that they have no affiliations or involvement with any organization or entity that has a financial interest or non-financial interest in the subject matter or materials discussed. Financial interests include honoraria, educational grants, participation in speakers' bureaus, membership, employment, consultancies, stock ownership, equity interest, expert testimony, or patent-licensing arrangements. Non-financial interests include personal or professional relationships, affiliations, knowledge, or beliefs.

Funding

This study did not need external funding to be carried out, each 30-minute therapy session was carried out free of charge by the therapist.

Authors' contributions

All authors contributed equally to the conception of this article.

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