Journal of Bodywork and Movement Therapies (■■■■) ■, ■■■–■■■

ELSEVIER

Journal of Bodywork and Movement Therapies

www.elsevier.com/jbmt

RETROSPECTIVE STUDY

Rolfing structural integration treatment of cervical spine dysfunction

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Received 14 September 2007; received in revised form 28 June 2008; accepted 1 July 2008

KEYWORDS
RSI;
Structural integration;
Fascia;
Rolfing;
Motion;
Pain;
Neck;
Physical therapy

Summary

Background: Misalignments in the body compromise the architectural integrity. At the tissue level, fascia shortens and thickens as the body engages in compensatory strategies to maintain itself upright; these changes are known as myofascial contractions. In physical therapy, there are several methods by which practitioners treat neck dysfunction. However, studies showing the effect of those techniques are limited.

Purpose: The purpose of this study was to investigate the effect of rolfing structural integration (RSI) in neck motion and pain levels of 31 subjects who received RSI. RSI is a type of therapy that focuses on aligning the human body with gravity.

Methods: This retrospective study, over a period of 3 years of clinical practice, analyzes changes in motion and pain levels at the neck for 31 subjects who completed the RSI in 10 basic sessions. Participants were evaluated before and after they received RSI. The data collected included: age, sex, occupation, referral source, diagnosis, height, weight, photographs of postural views, range of motion (ROM), pain, and functional complaints. ROM was assessed with the use of an arthordial protractor. Data analysis using three-way analysis of variance (ANOVA) tested the hypothesis at a significance of 0.5.

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doi:10.1016/j.jbmt.2008.07.002

Results: The mean pain levels and active range of motion (*AROM*) of the neck before RSI significantly changed after the treatment ($p < 0.5$): there was a decrease in pain and an increase in *AROM*. Pain levels/*AROM-Age* within-subject effect demonstrated significant difference only in *pain at best* and *rotation right*; the mean pain levels in the older group decreased by 67%, and the mean *AROM* for *rotation right* in the younger group increased by 34%.
Discussion: In this sample, *pain now* was reduced more than *pain best* and *pain worst*. Increased motion for *lateral flexion* was more than *rotation*, *extension*, and *flexion*.
Conclusion: This investigation demonstrates that the basic 10 sessions of RSI, when applied by a physical therapist with advanced RSI certification, is capable of significantly decreasing pain and increasing *AROM* in adult subjects, male and female, with complaints of cervical spine dysfunction regardless of age.

The role of the fascia in therapeutic interventions has been considered by practitioners of acupuncture, massage, structural integration, chiropractic, and osteopathy, but evidence-based practice is limited. Many practitioners using these techniques work with the fascia ignoring the sophisticated equipment and the methods by which researchers are looking at this organ. Fascia studies have considerably increased in the last 3 years. A Medline search indicated that in the last 3–4 years titles or abstracts with the word "fascia" increased by more than 600% from 4 to 18 years ago. Although the fascia is being studied in laboratories and clinics, there is still a strong need for further clinical exploration of this organ (Findley and Schleip, 2007).

Studies assessing the benefits of treatments for neck dysfunction are rare. When the words "rolfing," "fascia," "neck," "pain," and "range of motion" were used as keywords on Medline, the search provided only six articles, two articles assessed the benefits of acupuncture, one assessed the benefits of acupressure, two assessed the benefits of manual therapies, and one article correlated trigger points with neck pain. ScienceDirect provided no results and EBSCO/CINHAL provided one article when these words were used as keywords.

This research seeks to document the changes in active range of motion (*AROM*) and pain levels of patients who received the 10 sessions of rolfing structural integration (RSI) (see Table 1) complaints of neck pain and stiffness. This retrospective study examined a period of 3 years of clinical records for changes in motion and pain levels of the neck in 31 subjects who completed the 10 basic sessions to determine if RSI decreases pain, increases *AROM*, as well as whether there is a response difference in younger versus older adult patients.

RSI is a type of soft tissue mobilization therapy that focuses on aligning and balancing the body with gravity to maximize functional levels (Findley and Schleip, 2007). This technique repositions the components of the human body in a vertical alignment so that the head, shoulder, thorax, pelvis, and legs are aligned with gravity (Perry et al., 1981; Weinberg and Hunt, 1979; Findley and DeFilippis, 2005). When the body is structurally integrated, the force of gravity is controlled more effectively, so that the body's need of energy is decreased, and the movement capacity is improved (Perry et al., 1981; Weinberg and Hunt, 1979) as the pain decreases to allow functional activities.

In the 1920s Dr. Ida P. Rolf, after graduating from Columbia University with a Ph.D. in biochemistry, developed a holistic method that incorporates soft tissue manipulation and movement training that facilitate the activities of daily living (Findley and DeFilippis, 2005). Dr. Rolf's interest in the characteristics and function of collagen was the subject of her dissertation, as well as her work as a research fellow at the Rockefeller Institute. Her work evolved into the RSI methodology.

Dr. Rolf believed that when the internal structures are out of place the body fights against gravity. Rolf is quoted as saying (Findley and DeFilippis, 2005):

> Some individuals may perceive their losing fight with gravity as a sharp pain in their back, others as the unflattering contour of their body, others as a constant fatigue; yet others as an unrelentingly threatening environment. Those over 40 may call it "old age." And yet these signals may be pointing to a single problem, so prominent in their own structure, as well as others, that it has been ignored: they are off balance. They are all at war with gravity.

Table 1 Description of the 10 sessions of RSI.

Session 1: The focus of this session is breathing. Myofascial release is applied to the muscles of the trunk, ribs, shoulder, neck, and head. They also mobilize the hip and legs to align the pelvis horizontally. The assessment and treatment of specific problems is addressed throughout every session.
Session 2: The focus of this session is posture. They balance the feet, lower legs, and knees to correct the spinal curvatures.
Session 3: The focus of this session is spinal elongation. They work on the lateral aspect of the body to create elongation of the spine.
Session 4: The focus of this session is stability of the legs. They work on the plantar arches, and medial aspect of the lower extremity. The spine is mobilized and continues to be elongated.
Session 5: The focus of this session is to balance the trunk with the legs. They work on the abdominal, pelvic, and the iliopsoas muscles. The outer abdominal wall is elongated and mobilized to create continuity with the inner tissues.
Session 6: The focus of this session is to improve trunk mobility with stabilization of the pelvis and lower extremities. They work on the posterior pelvis, back, neck, and head.
Session 7: The focus of this session is to balance the rhythm of cranial movements. Work is done in the upper back, shoulders, neck, cranium, and facial structures.
Session 8: The focus of this session is lower body integration. Work is done to the pelvic girdle and extremities. Specific problems become a priority in the treatment.
Session 9: The focus of this session is upper body integration. Work is done to the pelvic girdle and extremities. Specific problems become a priority in the treatment.
Session 10: The focus of this session is to correct the level of the structures bilaterally during static and dynamic activities. Specific problems become a priority in the treatment. Specific problems are assessed and treated throughout the 10 sessions (J).

Factors such as poor posture, injury, or stress can contribute to misalignments in the body, which in turn compromise its architectural integrity. At the tissue level, fascia shortens and thickens as the body engages in compensatory strategies (Findley and DeFilippis, 2005).

Fascia creates continuity throughout the body. It is found in and around all the cells in the body, including myofibrils and all the organs. It is believed that fascia is the organ of form, because it is essential in the postures and the patterns of human movements (Schleip, 2003). The fascia contains the anatomical structures that give shape, form, stability, and support to the body, so that when forces are applied to one point they can be distributed to be absorbed by the entire body (Findley and DeFilippis, 2005). Fascia makes up the aponeuroses, the joint capsules, and wraps the muscles as the endo-, peri-, and epimysium (Schleip, 2003; Levange and Norkin, 2000), and extends as tendons, sharpey's fibers, and periosteoum. It also forms the retinacula when it thickens transversally across bones to prevent tendons from expanding out of place during muscle activity; an example is found at the carpal tunnel (Levange and Norkin, 2000).

The superficial fascia is located under the skin, and facilitates skin movement and temperature regulation. The deep fascia is denser and highly organized (Levange and Norkin, 2000). It creates compartments for groups of muscles that perform specific movements (Moore and Dalley, 1999). When the deep fascia deteriorates, it may lose its ability to limit expansion, allowing structural changes, such as varicose veins (Moore and Dalley, 1999). Therefore, when the structure of the fascia is altered, stiffness or weakness of the muscles can be experienced. Moreover, when the internal structures are altered, their intra- and inter-muscular facial sheets lose their ability to slide over one another, and therefore movement is decreased (Findley and Schleip, 2007). Dupuytren disease, plantar fibromatosis, club foot, and frozen shoulder are examples of changes in the structure of the connective tissue/collagen (Schleip, 2003).

Trauma to the fascia makes it thicker and shorter by positioning new connective tissue in a random manner. Inflammation due to repetitive use causes the connective tissue to be aligned with the lines of force in a fashion that compromises the biomechanics of the system (Findley and DeFilippis, 2005; Goodman et al., 2003; O'Sullivan and Schmitz, 2001).

These changes produce pain and stiffness.

RSI focuses on teaching the body to move in a more efficient and effective way by reversing strain and rigidity, while increasing its potential (Findley and DeFilippis, 2005).

In rolfing, practitioners employ a sequence of soft-tissue manipulation techniques designed to enhance the symmetry and the balance of the human structure. They work on the fascia and connective tissue with their fingers, open hands, clenched fists, and elbows (Perry et al., 1981). The pressure they apply is directed to release the adhesions between what should be sliding structures (Findley and Schleip, 2007). The quantity of pressure they apply determines the amount of myofascial release and depends on the patient's ability to allow the change (Fahey, 1989). Practitioners of this technique believe that contractures in the fascia do not have to be permanent changes because the chemical alterations of the matrix that are made of connective tissue can be rearranged so that collagen fibers can move again (Findley and Schleip, 2007). Rolf practitioners apply the collagen concepts to fascial structure and function (Schleip, 2003). They believe that improvements to the structure of the human body directly correlate with improvements in physiological and psychological functioning (Findley and DeFilippis, 2005; Cottingham et al., 1988) and that fascia adapts to physical stress, so that when they press against tissue fascia changes its density, tonus, or organization (Schleip, 2003).

The effect of pressure on collagen has been documented by various authors:

- Deutsch et al. (2000) reported the use of RSI for the treatment of chronic pain. Twenty subjects with chronic pain in the low back, cervical region, extremities, and other area demonstrated significant ($p = 0.05$) improvements in ROM, posture, pain, and function. This sample reported a 74% decrease in pain and an increase of 85% in ROM.
- Cottingham et al. (1988) documented the effects of RSI on the pelvic inclination angle and parasympathetic tone on 32 subjects with anterior tilted pelvis. They measured the inclination of the pelvis with an inclinometer, and the autonomic tone was deduced from the heart rate. Their results indicated significant decreases in standing anterior pelvic tilt immediately after RSI treatment, and 24 h after the treatment. Also reported was an increase of vagal tone in the subjects immediately after they received myofascial manipulation of the iliopsoas, deep hip rotators, and the hamstrings ($p < 0.01$). There are two possible clinical applications to their findings: (1) RSI can be used to treat low back pain associated with anterior tilt of the sacral base and the pelvis, and (2) musculoskeletal disorders associated with autonomic stress disorders. Increases in vagal tone correlate with decreases in sympathetic nervous system activity, suggesting the use of RSI for treatment of autonomic dysfunctions (Cottingham et al., 1988).
- Weinberg and Hunt (1979) analyzed the means for state anxiety questionnaire scores before RSI and 5 weeks after RSI. There were 24 subjects assigned to the control group and 24 subjects in the experimental group. A significant decrease in anxiety in subjects who received RSI was reported ($p < 0.01$).
- Perry et al. (1981) looked at functional effects of rolfing on cerebral palsy. Ten patients diagnosed with cerebral palsy, from 10 to 42 years old (y.o.), received the 10 sessions of RSI. The analysis of the data revealed that subjects with mild impairments improved gait velocity, stride length, and cadence, while subjects with moderate impairments slightly improved gait velocity.

The purpose of this retrospective study was to determine the effect of RSI on neck pain and motion of $N = 31$ patients who sought treatment for complaints of pain and limited motion in neck.

Methods

There were a total of 727 prospective subjects from a local physical therapy private practice. These subjects were treated by a physical therapist who is also an RSI advanced practitioner and a Professor Emeritus of the Physical Therapy Department at California State University, Fresno. These prospective subjects had been evaluated between February 7, 1982 and November 18, 2005.

The first 100 clinic records reviewed were selected from the first 142 patients evaluated between 02/07/82 and 06/02/89. These were all the subjects who completed the 10 sessions of RSI during that period of time. By the end of this phase, it was decided to first review one half of 727 clinic records of prospective subjects to reduce the review time by half; thus the second clinic record review phase was modified.

The next 174 clinic records reviewed were selected from the patients evaluated between 7/20/89 and 11/18/05; these were all the subjects who completed the 10 sessions of RSI and whose patient number ended in the digits 0, 1, 2, 3, and 4. The addition of these conditions reduced the number of prospective subjects to accommodate the time available to complete the study. From this second group 18 subjects were selected for the study and a final group from the patients evaluated between 7/08/02 and 11/18/05 was selected to increase the number of subjects.

The last 13 clinic records selected for review were all the subjects who completed the 10 sessions of RSI and whose patient number ended in the digits 5, 6, 7, 8, and 9. The modification of these conditions increased the number of subjects in this retrospective study to 31. There were a total of 291 charts reviewed and transcribed to Microsoft Excel spreadsheets.

Variables

The independent variable was the 10 sessions of RSI with four levels of groups: younger subjects, older subjects, males, and females. The subjects with the median age (52 y.o.) and the subjects older than the median age (15 subjects) were classified as "older subjects." There were 15 subjects younger than the median age and were classified as "younger subjects." This procedure divided the group in an older/younger ratio of 1:1.0667. Younger subjects were between 22–49 y.o. Older subjects were between 52–66 y.o. The dependent variables were *pain best*, *pain worst*, *pain now*, *rotation left*, *rotation right*, *flexion left*, *flexion right*, *extension*, and *flexion*.

Sample

The subjects for this retrospective study of complaints of neck pain and limited *AROM* were extracted from the total of all patients seen at this physical therapy practice for RSI. Cases included in the sample met the criteria for this study: (1) complaints of neck pain, (2) documented pre- and post-pain scales, and (3) *AROM* measures in the medical records. The subjects meeting the criteria included 6 males and 25 females 22–66 y.o. for $n = 31$ (see Table 2); they received services between June 18, 2002 and July 5, 2005.

The medical records for these patients indicated that they had been treated by other health practitioners such as chiropractors, acupuncturists, massage therapists, physical therapists, and Reiki practitioners, energy work, and Bowen techniques before they received RSI.

Participants were evaluated for complaints of neck pain and stiffness. Pain levels and ROM measurements were taken during the initial and final evaluations. The clinical data collected included: birth date, age, gender, dates of initial and final evaluations, complaints before, during, and after RSI, occupation, prior treatments, etiology, medications, referral source, diagnosis, height, weight, photographs, pain, and *AROM*. The data was collected as part of the initial evaluation by a physical therapist, and provides the baseline to determine functional limitations, interventions, and outcomes of the subject.

In order to qualify for the study the subjects had to meet the following criteria:

(1) Completed the 10 sessions of RSI.
(2) Complained of neck pain during the initial evaluation.
(3) Rated their pain level on a pain scale before and after rolfing.
(4) The measurements of the *AROM* for their *neck rotation*, *lateral flexion*, *extension*, and *flexion* were available.

There were 31 subjects who met the criteria.

AROM of the *neck rotation*, *lateral flexion*, *flexion*, and *extension* were assessed with an arthrodial protractor (REEDCO Research). The protractor is made of clear plexiglass with 180° graduated in 5° intervals. The protractor is aligned with standard boney landmarks of the subject's body used to observe and record the available *AROM* for each subject.

Pain levels were assessed using a self-reporting pain form. Fifteen subjects reported their pain level on a 0–5 scale, 0 representing no pain and 5 representing the worst pain possible. Sixteen subjects reported their pain level on a 0–10 scale, 0 representing no pain and 10 representing the worst pain possible. In order to merge the data and conform to the larger 0 to 10 sample, 0–5 pain scale values were converted by multiplying the values by two.

Three-way analysis of variance (ANOVA) was used to test the hypothesis with SPSS software (SPSS Inc., Chicago, IL). The significant level was set at 0.05.

The 10 sessions of RSI modify asymmetries of standing postures by mobilizing the myofascial tissues (Findley and Schleip, 2007). Sessions are individualized based upon the integrity of the soft tissue palpated, the posture observed and measured, and individual's complaints of dysfunction (Kuchars and Swan, 1992).

Results

There were statistical significant differences ($p \leqslant 0.05$) between the levels of *pain* and *AROM* after the subjects received the 10 sessions of RSI (see Table 3). The levels of pain reported at *best*, *worst*, and *now* were significantly lower, and the amount of *AROM* into *rotation*, *lateral flexion*, *extension*, and *forward flexion* were significantly increased after RSI.

However, when the younger subjects were compared to the older subjects, the *pain at best* and the *rotation to the right* were the only variables that achieved statistical significance

Table 2 Demographics of subjects.

Ss	Age	Sex	Job	Diagnosis	Referral	Etiology	Prior treatment
1	24	M	Unemployed	*	DC	*	*
2	59	F	*	*	*	*	*
3	60	F	*	Low back pain	MD	Heavy lift	DC, neuro-emotional tech kinesio
4	47	M	Not employed	*	SELF	Costochondri	*
5	53	F	Office	*	MD	*	Physical therapy—PT
6	55	M	Educator	Myofascial pain	MD	MVA	PT, acupuncture, meds, massage
7	66	M	Office	Chronic back/neck pain	MD	Sports	DC
8	26	F	Educator	Up back Ms spasm	MD	*	*
9	49	F	Office	Cervical/lumbar pain	MD	Stress	Massage
10	42	F	Therapist	Co-neck/shoulder pain	SELF	MVA	Massage
11	45	F	Office	*	DC	*	*
12	54	F	Office	*	MD	Stress/Ms pull	PT, Reike
13	56	F	Educator	Fibromyalgia	MD	*	PT, massage, Meds
14	53	F	*	*	MD	Cervical congen fusion	PT
15	49	F	Student	*	YOGA	MVA	DC
16	48	F	Educator	*	MD	*	DC
17	55	F	Office	Neck pain	LCSW	Psych Trauma	Therapy
18	30	F	Not employed	Scoliosis	SELF	Spine pain	PT, mothers
19	26	F	Office	Right shoulder pain	MD	Muscle pull	PT, acupuncture
20	49	M	*	*	MD	Sports	PT, Meds
21	54	F	Therapist	*	MD	MVA	DC, PT, energy wk, Bowen tech
22	52	F	Educator	*	MD	MVA	Massage, Meds, surgery
23	29	F	*	*	MD	Adhesive capsule	Acupuncture, PT
24	64	F	Health care	Headaches	MD	*	DC, acupuncture, massage, PT, Meds
25	55	F	*	Low back surgery	MD	MVA	Meds
26	44	F	*	*	MD	*	*
27	55	M	Office	Neck/shoulder pain	SELF	*	Acupuncture, massage
28	44	F	Office	Spinal stenosis	SELF	*	Meds
29	46	F	Office	Neck pain	ACUPUNC	MVA	Acupuncture, DC, massage, Trager
30	53	F	Office	Neck/shoulder pain	MD	*	Nothing
31	56	F	Educator	*	MD	*	PT, DC, personal trainer

Note: Information * missing in Table 2 reflect the unfortunate circumstance that exists in clinical record keeping. That is, as time passes information is either lost from files, or as clinicians get busy occasional data points are not recorded. These issues commonly occur in retrospective studies of clinical files which are maintained for the purpose of provision of services, versus data collected with the original intent of research.

(see Table 3). The older subjects demonstrated a significant reduction of *pain at best*. The younger subjects demonstrated a significant increase in *neck rotation to the right*. Correlations between *neck rotation to the right* and neck *pain* provocation with neck rotation to the right were not assessed due to insufficient data gathered at the time of initial evaluation. Gender differences were not analyzed due to few male subjects ($N = 6$) versus female subjects ($N = 24$) in the sample (see Table 2).

Pain

The mean values of pain levels for all the subjects significantly decreased following the 10 sessions of RSI (see Table 3). The mean values of *pain at best* decreased from 1.6 to 0.6. The mean values of *pain at worst* decreased from 8.0 to 4.9. The mean values of *pain now* decreased from 3.1 to 1.1. The mean value of *pain at best* after the treatment in older subjects significantly decreased from 2.1 to 0.7. There were not significantly changes in the

Table 3 Descriptive statistics and ANOVA for pain levels and AROM pre-/post-RSI.

Neck	All subjects									Neck		
	Min		Max		$X \pm SD$		ANOVA					
	Before	After	Before	After	Before	After	MS	F	*p*-Value			
Pain best	0	0	6	4	1.6±2.3	0.6±1.1	11.14	4.41	0.045	Pain best		
Pain worst	4	0	10	9	8.0±1.8	4.9±2.8	101.71	26.64	0.000	Pain worst		
Pain now	0	0	8	5	3.1±2.3	1.1±1.6	23.81	6.88	0.014	Pain now		
Rotation L	20	30	80	90	52±14.2	65±12.2	1307.77	15.93	0.000	Rotation L		
Rotation R	10	40	80	90	51±14.2	64±10.6	2335.35	26.01	0.000	Rotation R		
Flexion L	10	20	45	50	25±9.1	33±8.9	628.63	46.7	0.000	Flexion L		
Flexion R	10	10	35	40	22±7.8	29±8.2	525.74	33.1	0.000	Flexion R		
Extension	40	40	90	90	72±13.3	77±12.4	470.15	28.8	0.000	Extension		
Flexion	0	0	50	70	39±11.8	44±12.6	257.61	9.73	0.004	Flexion		
Neck	Young subjects						Old subjects					
	Min		Max		SD		Min		Max		SD	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Pain best	0	0	6	3	0.95±1.9	0.43±0.94	0	0	6	4	2.1±2.4	0.69±1.3
Pain worst	4	0	10	9	7.67±2.1	4.22±3.1	6	2	10	9	8.2±1.3	5.6±2.3
Pain now	0	0	8	4	2.78±2.3	1.20±1.6	0	0	8	5	3.3±2.4	1.1±1.6
Rotation L	20	30	80	90	52±18	67±11	25	50	70	80	52±10	63±9
Rotation R	10	40	80	90	50±18	67±11	30	40	65	70	52±10	61±9
Flexion L	15	20	40	45	28±7	34±8	10	20	45	50	23±10	31±10
Flexion R	10	10	35	40	24±7	31±9	10	15	35	40	20±8	27±8
Extension	40	40	90	90	73±13	77±14	40	50	90	90	71±14	78±11
Flexion	0	0	50	60	37±13	41±15	20	30	50	70	40±10	47±10

remaining types of pain between younger and older subjects.

Range of motion

The mean values of *AROM* for all the subjects significantly increased after the treatment (Table 3). *Neck rotation left* increased from 52° to 65°, a gain of 13° beyond a ROM rater error of 5 (Reese and Bandy, 2002). *Neck rotation right* increased from 51° to 64°, also a gain of 13°. *Left lateral flexion* increased from 25° to 33°, a gain of 8°. *Right lateral flexion* increased from 22° to 29°, a gain of 7°. *Neck extension* changed from 72° to 77°, a gain of 5°. *Neck flexion* increased from 39° to 44°, a gain of 5°. The mean value of *neck rotation right* after the RSI treatments in younger subjects significantly increased from 50° to 67°, a gain of 17°. There were no statistically significant changes in the remaining neck motions between younger and older subjects.

Discussion

The results of this investigation demonstrate that RSI reduces neck pain and increases the movement of the neck. The minimum, maximum, and the mean values for *pain at best*, *worst* and *now* were reduced, and all motions of the neck were within normal ROM values after rolfing/RSI. All *AROM* gain for subjects in this study exceeded the 5° margin of ROM intra-rater error and inter-rater error reported by Kendall and McCreary (2005) as the source of increased neck ROM.

Pain now was reduced the most by rolfing (see Figure 1). The *pain now* mean value decreased

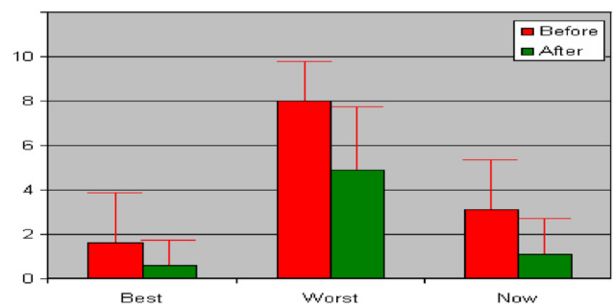

Figure 1 Pain reports pre/post RSI (mean best before = 1.6, SD = 2.3; mean best after = 0.6, SD = 1.1; mean worst before = 8.0, SD = 1.8; mean worst after = 4.9, SD = 2.8; mean now before = 3.1, SD = 2.3; mean now after = 1.1, SD = 1.6).

by 65%; it was followed by *pain at best* with a 63% reduction, and *pain worst* with a 39% reduction. The descriptive statistics also indicate that there is more dispersion in the *pain at worst* than in *pain at best* and *pain now* values. The standard deviation for *pain at worst* is 2.8, whereas for *pain at best* and *pain now* are 1.1 and 1.6, respectively (see Table 2). The *F* ratio for all the *pain* variables indicates that the treatment had a positive influence, and the variation between groups could not be attributed to random error alone. The *F* ratio that least exceeded the critical value (2.07) corresponded to *pain at best* ($F = 4.4$) of the neck; the *F* ratio for *pain at worst* was the highest, indicating a high variance between the before and after values. The null hypothesis can be rejected, as there is a statistically significant effect from RSI resulting in a reduction of symptoms.

The motion in the neck that was increased the most was *lateral flexion* (see Figure 2); the mean value increased from 25° to 33° on the left side and from 22° to 29° on the right side, differences of 8° and 7°, respectively; these correspond to a 32% increase after RSI from the mean value before RSI. *Rotation* had the next most significant increase of 13° that corresponds to a 25% increase in motion to either side. *Extension* and *flexion* increased the least, with changes of 7% and 13%, respectively; both of these motions increased 5° (see Table 2). The large *F* ratio for all the *AROM* variables indicates that the treatment had significant influence, and the variation between groups could not be attributed to random error alone. There is a highly significant ($p < 0.01$) difference between the values of *AROM* before and after the treatments.

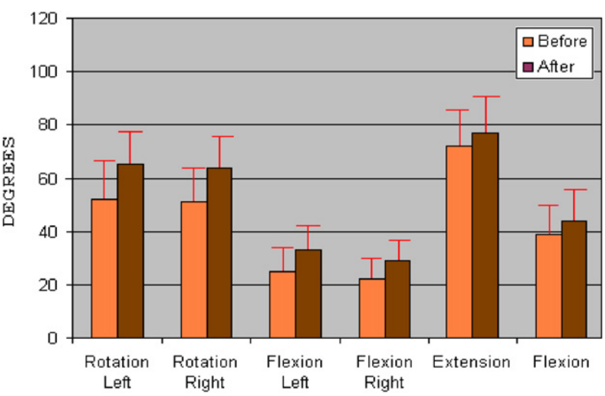

Figure 2 Mean *AROM* before and after RSI (mean rotation left before = 52, SD = 14.2; mean rotation left after = 65, SD = 12.2; mean rotation right before = 51, SD = 14.2; mean rotation right after = 64, SD = 10.6; mean flexion left before = 25, SD = 9.1; mean flexion left after = 33, SD = 8.9; mean flexion right before = 22, SD = 7.8, mean flexion right after = 29, SD = 8.2; mean extension before = 72, SD = 13.3; mean extension after = 77, SD = 12.4; mean flexion before = 39, SD = 11.8; mean flexion after = 44, SD = 12.6).

This study supports the expected clinical correlation between neck pain and neck ROM: the more the pain that subjects feel, the less likely it is that they will move the neck. When the neck is out of alignment with the body posture, the fascia alters to compensate for changes in the redistribution of forces within the body (Findley and DeFilippis, 2005). These changes decrease the gliding properties of structures such as muscles, tendons, and nerves (Findley and Schleip, 2007) that ultimately may promote entrapment or compression of pain receptors as the joints are moved. Therefore, RSI may decrease pain in the neck by preventing nerves from being compressed or overstretched as a result of decreasing tension in the surrounding fascia. Increases in *AROM* may be attributed to a decrease in tension of the fascia and contractile tissue, allowing restoration of resting muscle length.

When muscles are in a sustained contraction, blood flow is restricted, cells become poorly supplied with cell nutrients, waste products are not eliminated properly, and free nerve endings are excited. These changes ultimately may manifest as pain (Cailliet, 1981). Tissue becomes nourished during activity and through tissue mobilization by the mechanical action that squeezes blood in and out of the vessels in the tissue. Mechanical skillful treatment of the soft tissue of the neck promotes circulation by relaxing the muscles, hence increasing blood flow and decreasing pain.

In young people the fascia is properly hydrated maintaining its strength and flexibility, while in older people the fascia becomes thicker and firm as the collagen and elastin fibers increase their density (Bottomley and Lewis, 2003), making it more difficult to release the fascia in older people.

Hunt (1995) further illustrates myofascial contractions:

> Today there are numerous manipulative and exercise programs, like rolfing, which loosen and relax the connective tissues of the body. Now we know that connective tissue has piezoelectric capacities, which can act like an electrical system, where stretching enhances the electrical capacity. Therefore, we conjectured that connective tissue was more than a tissue scaffolding. It seemed to dictate the flow of electromagnetic energy throughout the body at the fitness level.

In this study, *pain at best* and *neck rotation right* were the only variables that responded differently

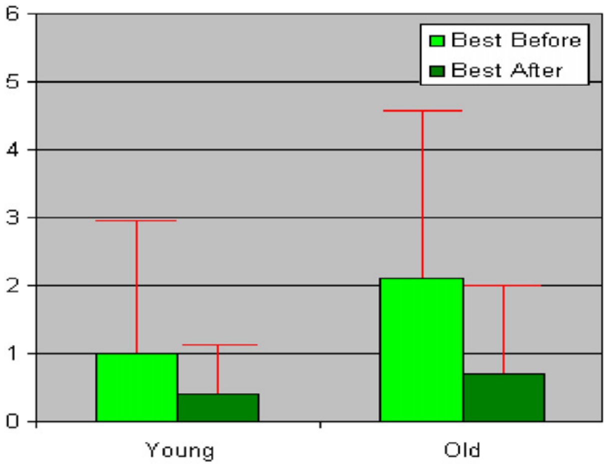

Figure 3 Mean pain at best levels for older and younger participants before and after RSI. (Young: mean best before = 1.0, SD = 1.9; mean best after = 0.4, SD = 0.9. Old: mean best before = 2.1, SD = 2.5; mean best after = 0.7, SD = 1.3.)

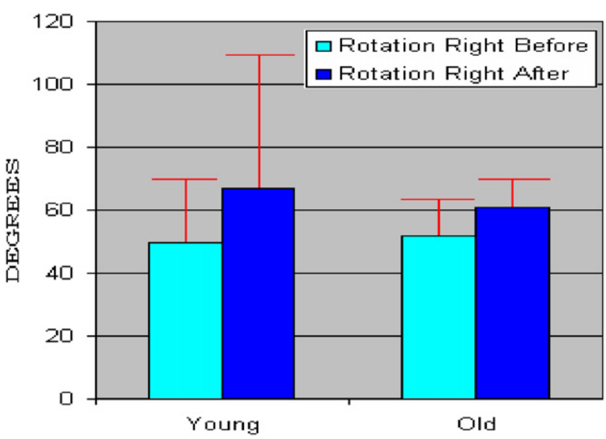

Figure 4 Mean *AROM* for older and younger participants before and after RSI. (Young: mean rotation right before = 50, SD = 17.6; mean rotation right after = 67, SD = 42.1. Old: mean rotation right before = 52, SD = 10.6; mean rotation right after = 61, SD = 9.4.)

between younger and older subjects (see Figures 3 and 4). The mean *neck rotation to the right* before RSI/rolfing in young and old participants was 50° and 52°, respectively; however, in young subjects the *neck rotation to the right* increased by 34% (17°) while in older subjects it only increased by 17% (9°). Older subjects described having more *pain at best* than younger subjects before and after RSI, indicating that untreated pain not only gets worst with time, but it also becomes more difficult to treat. Younger subjects decreased their pain by 60% (0.6 points), and older subjects decreased their pain by 67% (1.4 points).

Limitations of the study

Based on the results of this study, it is recommended that additional assessment tools be incorporated in further RSI research. Follow-up studies are needed at intervals such as 6 months and 1 year after completing the 10 sessions of RSI to address long-term benefits and frequency needed to maintain the benefits of the treatment. None of the subjects in this study are known to have had a second series of RSI. Because of the significant improvements demonstrated in this investigation, analysis of possible improvements in pain levels and *AROM* in the back and extremities may help to determine the overall effect of RSI on the entire body. Because subjective information revealed functional improvements, inclusion of functional tests and self-reporting assessments (e.g. Gait, Posture, Tinnetti Performance-Oriented Assessment of Mobility, Berg Balance Scale, Fullerton Advanced Balance Scale, Dynamic Gait Index, Balance Efficacy Scale, Pain Disability Index, and/or Neck Pain and Disability Index) are recommended during the initial and final evaluations, as well as in clinical practice to determine if there are significant changes in activities of daily living and quality of life.

Conclusion

This investigation suggested that the basic 10 sessions of RSI, when applied by a physical therapist with advanced RSI certification, decreases pain and increases cervical *AROM* in adult subjects, male and female, with complaints of cervical spine dysfunction, regardless of age.

The improvements did not differ between young versus old, with the exception of *pain at best* and *neck rotation to the right*.

Moreover, RSI appears to be more effective in reducing neck pain at best in older clients (52–66 years old) than in younger clients (22–49 years old). In younger clients, RSI is more effective in increasing *neck rotation right* than in older clients. Neck pain at best decreased in all ($p = 0.045$), with more decrease in the aged than in the younger ($p = 0.041$). *AROM* rotation to the right increased in all ($p = 0.000$), with more increase in the young than in the aged ($p = 0.035$); the *AROM* rotation to the right dysfunction corresponds to hand dominance in the sample group.

There were no differences between younger versus older subjects for pain worst, pain now, rotation left, flexion left, flexion right, extension, and flexion. Younger and older participants experienced the same benefit from the treatments ($p = 0.347$, 0.162, 0.611, 0.904, 0.921, 0.077, and 0.924, respectively).

Further research is indicated to determine if similar outcomes are demonstrated by larger samples and by other practitioners utilizing structural integration methology.

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