대한침구학회지 제21권 제6호(2004년 12월)
The Journal of Korean Acupuncture & Moxibustion Society

원 저

Increased cervical lordosis after deep acupuncture in patients with neck pain : nonrandomized clinical control trial

Lee Seung-deok

Department of Acupuncture and Moxibustion, College of Oriental Medicine, Dong-Guk University

국문초록

경추통 환자에게 있어서 內經의 深刺방법이 경추 전만의 각도 변화에 미치는 영향

이승덕

동국대학교 한의과대학 침구학교실

목적 : 경추통에 대한 침구치료의 효과여부가 현재까지 시행된 무작위 대조군 시험의 검토에서 논란이 되고 있는데, 경추통에 대한 치료 효과의 검증에 최근 들어 경추 전만각도의 변화를 측정하는 것이 점차 많이 사용되고 있는 실정이다. 하지만 아직까지 변형된 형태의 경추 견인 등 몇몇 요소들이 경추 전만을 변화시켰다는 보고는 있었으나, 침치료 중 深刺의 방법이 경추의 만곡을 변화시켰다는 보고는 없었다.

* Acknowledgement "This work is supported by the Dong-Guk University Research Fund"
· **접수** : 2004년 11월 18일 · **수정** : 2004년 11월 26일 · **채택** : 2004년 11월 27일
· **교신저자** : Lee Seung-deok, Department of Acupuncture and Moxibustion, Gangnam Oriental Medical Hospital, Dong-Guk University, 37-21, Nonhyundong, Gangnam-gu, Seoul, Korea
Tel. 82-2-3416-9738 Fax. 82-2-542-3280 E-mail : chuckman@dongguk.edu

방법 : 자침의 방법 중 深刺(五刺法 중 合谷刺 또는 關刺)방법이 경추 전만의 변화를 주는가에 대하여 검증하기 위하여 심자 치료를 시행한 19명의 실험군과 치료를 시행하지 않고 단순히 방사선 촬영만 시행한 21명의 대조군의 단순 방사선 사진을 후향적 연구의 방법으로 비교하였으며, 아울러 심자 자침군에서는 VAS를 측정하여 통증의 정도의 변화를 함께 연구하였다.

결과 : 연구결과 자침을 시행하지 않은 대조군에서는 VAS와 경추 전만의 Cobb각도에서 유의성 있는 변화가 나타나지 않았으나, 심자의 방법으로 자침한 군에서는 치료 전후의 VAS가 유의한 차이를 나타내었고, 경추의 전만 각도에서도 경추 2번과 7번 사이의 Cobb의 각도에서 유의성 있는 변화를 나타내었다($p < 0.05$).

결론 : 이러한 연구 결과들은 심자의 자침방법이 경추의 통증을 줄여줄 뿐만 아니라 경추의 구조적 변화를 일으킬 수 있음을 나타내 주는 것이다.

I. Introduction

Neck pain is a common complaint with a point prevalence from 10% to 18% and lifetime prevalence from 30% to 50%. In many cases symptoms persist, causing severe discomfort and inability to work[1-2].

Neck pain can originate from disorders in the neck, such as neural tissue, uncovertebral or intervertebral joints, discs, bones, periosteum, muscles, and ligaments.

Abnormal curves in the cervical spine are more common in patients with cervicocranial symptoms[3-4]. Intuitively, the relationship between neck pain symptoms and loss of cervical lordosis makes sense, because the cervical lordosis can be considered a primary curve, as it is formed at approximately 10 weeks of fetal development[5].

Recently, the configuration of the sagittal cervical curve has reemerged as an important clinical outcome of health care[3-4,6], the state of the cervical lordosis has been of interest to the chiropractic and medical professions[4,7].

Conservative methods to restore or improve cervical lordosis are rare, in a 1998 review of the literature[8], only 5 studies from the chiropractic literature addressed the issue of restoration of the cervical curve via chiropractic treatment methods. Of these 5 studies, only Harrison DD et al[9], Wallace HL et al[10] were considered to be of adequate quality.

Neck pain is frequently treated by physical therapies such as exercise, traction, heat and cold therapies and electrotherapies[11]. Current treatment increasingly includes complementary methods, of which acupuncture is one of the most common.

During the past decades, there has been an

increasing interest in summarizing and analyzing the available evidence on conservative management of neck pain. There is, however, a lack of evidence to support acupuncture as an effective treatment for chronic neck pain[11-12].

No previous study has reported the association between deep acupuncture and changes of alignment in upright cervical lordosis.

It was hypothesized that deep acupuncture would increase holding capacity of the deep cervical muscles and thereby restore cervical lordosis or increase the curvature in neck pain patients who had loss their cervical lordosis.

Ⅱ. Methods

1. Patients

For the purposes of this article, thirty nine patients with decreased cervical lordosis was included from of the Department of Acupuncture and Moxibustion, Dongguk University, Korea.

The criteria for inclusion and exclusion of the study sample were as follows:

1. Criteria of inclusion

* Neck pain and/nor Radiating pain and symptoms.
* Neutral lateral cervical radiograph taken in the natural standing position was obtained at the beginning of care and a like comparative radiograph was taken after a period of care.
* Conditions of decrease of cervical lordosis.
* There were any kyphotic angles in their lateral cervical curves.

2. Criteria of exclusion

* Prior cervical spine surgery.
* Compression fractures at any cervical level.
* Severe degenerative changes in the intervertebral disks, vertebral bodies, or spinal ligaments.

The 39 patients consisted of 18 female subjects and 21 male subjects, with an average age of 37.43 years (SD 9.7 years), they took follow-up lateral cervical radiograph and VAS pain scale.

The 18 treatment group, who was treated with deep acupuncture, consisted of 9 female subjects and 9 male subjects, with an average age of 34.77 years (SD 9.62 years).

The control group subjects selected not to receive care but did have initial and follow-up lateral cervical radiographs. The control group was composed of 14 female subjects and 19 male subjects, with an average age of 39.71 years (SD 9.18 years).

2. Intervention

1) The acupuncture procedure

An experienced acupuncturist carried out the acupuncture sessions, and the same points were used as for the treatment of neck pain.

The following points were used bilaterally or unilaterally(Table 1) : Within the neck area, six Huatuojiaji points(華佗夾脊穴), three interspinous points(椎間) and three channel point G12(Wangu, 完骨), G20(Fengchi, 風池), GV14(Dazui, 大椎) were used. In addition, the regional meridian

points G21(Jianjing, 肩井), SI14(Jianwaiyu, 肩外俞) and GI13(Quyaun, 曲垣) and the distal meridian points SI3(Houxi, 後谿), G41(Zulinqi, 足臨泣), B66(Zutonggu, 足通谷) and SI2(Qiangu, 前谷) were chosen.

Distal meridian points were selected according to the theory of SAAM Acupuncture[13] of Korean Traditional Medicine.

The disposable needles that were used, were Korea, made of stainless steel, Dongbang 0.32×50 mm. After standard disinfecting of the site, the needles were inserted through the skin to the depth of 30 ㎜ to 40 ㎜, and manipulated until the needle sensation (DeQi) was obtained. All experiments were repeated using electro-acupuncture. Low-frequency electrical stimulation (30 Hz) was evoked with the help of Multiple Electronic Acupunctoscope(Japan PG-306). The needles at points of neck and regional meridan points were connected to the electro-pulser bilaterally, and the electrical current was adjusted to produce a pulsating sensation, which was not painful (2-4 mA). The electrical stimulation was applied during the whole period the needles were in situ (20 minutes).

Table 1. Localization and frequency of acupuncture points treated in the acupuncture group

Acupuncture points	Depth(mm)	Bilaterally or Unilaterally
G12 Wangu(完骨)	30-40	Bilaterally
G20 Fengchi(風池)	30-40	Bilaterally
G21 Jianjing(肩井)	30-40	Bilaterally
GV14 Dazui(大椎)	30-40	Unilaterally
C4~7 Interspinous(椎間)	30-40	Unilaterally
C4~7 Huatuojiaji(華陀夾脊)*	30-40	Bilaterally
SI14 Jianwaiyu(肩外俞)	5-10	Bilaterally
GI13 Quyaun(曲垣)	5-10	Bilaterally
SI3 Houxi(後谿)#	1-5	Unilaterally
G41 Zulinqi(足臨泣)#	1-5	Unilaterally
B66 Zutonggu(足通谷)#	1-5	Unilaterally
SI Qiangu(前谷)#	1-5	Unilaterally

* : 華佗夾脊穴.

2) Scheduling of acupuncture

The acupuncture treatment frequency was 2 to 5 times weekly for total of 24.61±21.36 days. The number of inserted needles was about 20 and the number of visits before the second radiograph and examination were performed was 9.06 visits (SD= 8.6visits). The second radiograph and examination were performed after the subjects last treatment.

3. Evaluation

Standard lateral cervical radiographs were obtained with the subjects right shoulder against the cabinet with a standard tube distance of 182.9 cm. Before exposure, subjects were asked to close their eyes, flex and extend their skull twice, and assume a comfortable resting position where they perceived themselves to be looking straight ahead. The eyes were then opened, and the subject was asked not to deviate from this neutral position. This neutral resting posture has been shown to be highly repeatable and stable over time.[14]

Radiographs had to be of sufficient quality such that posterior tangent lines (Ruth Jackson lines) could be erected on the posterior body of C2 and C7 to ascertain the magnitude of lordosis between those 2 vertebrae.

Three examiners who were of varying levels of experience performed measurement of sagittal alignment on each radiograph.

Cobb method, posterior tangent and Relative rotation angle method are used to assess cervical spine sagittal alignment. Three of them use neutral lateral plain radiographs.

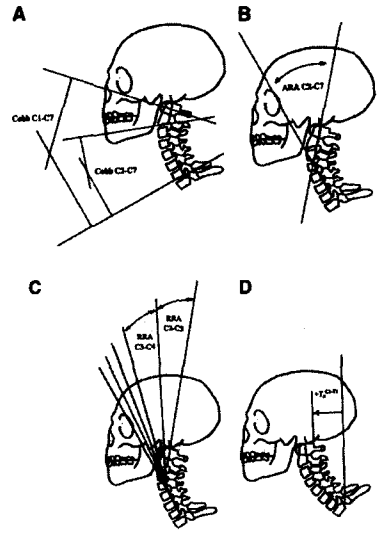

Fig. 1. Radiographic measurements[15]

(A) Two types of Cobb angles were drawn, C1-7 and C2-7.

(B) An additional global angle of lordosis (ARA C2-C7) was measured at the intersection of the posterior body tangent lines on C2 and C7.

(C) For a segmental analysis (eg, relative rotation angle [RRA] C2-3), intersections of each adjacent pair of vertebral body tangent lines drawn on the posterior body margins of C2 through C7 are measured.

(D) A measurement of head protrusion (anterior weight bearing = + Tz) is the translation distance from a vertical line through posteroinferior T1 to the posterosuperior corner of the atlas lateral mass.

4. Statistical Analysis

To compare between and within groups, 2-sample *t* test and 2-sided paired t test were conducted with the software S-Link (Version 2.2, S-Link,com., Korea, 2003). In a few instances when situations violated the needed

assumptions for the 2-sample t test and 2-sided paired t test, their respective nonparametric analogues, the Mann-Whitney test or Wilcoxon signed rank test, were utilized instead.

Ⅲ. Results

The 18 subjects who received deep acupuncture treatment were compared with the 21 controls who did not receive treatment. By using 2-sample *t* test and Mann-Whitney test, we found no statistically significant differences between the 2 groups when comparing sex, age, and pretreatment VAS scores(Table 2).

There was a statistically significant difference in the posttreatment VAS scores for these 2 groups. Wilcoxon signed rank test indicated that the pretreatment VAS (6.91±0.63) and posttreatment VAS (6.87±1.02) scores for the control group were not statistically significant (P= 0.83), there was, however, a statistically significant difference (P< .0001) for VAS scores in the deep acupuncture treatment group (mean, 7.40±1.06 vs 3.53±1.27; Table 2).

Table 2. Comparison of Control and Treatment Group Characteristics and Pain VAS Between Groups

Variable	Control Group (n=21)	Treatment Group (n=18)	P^*(between groups)
Female/male	9/12	9/9	
Age (y)*	39.71±9.18	34.78±9.6	0.1194
VAS of pre	6.91±0.63	7.40±1.06	0.0849
VAS of post	6.87±1.02	3.53±1.27	0.0000
Term of Follow	15.14±8.52 months	27.44±20.18 days	

Values are mean ± SD.

* : Two-sided 2 sample t test.

VAS pain range : 0 no symptoms, no limitations to daily living ; 10 severe pain and bed ridden.

Two-sided paired t tests for VAS scores within groups.

Using paired *t* tests for equality of the means derived from radiographic analysis for control subjects, there was no statistically significant differences in the 5 segmental angles from posterior tangents at C2-3 to C6-7. Also for the control group, no statistically significant differences existed in the global absolute rotation angle (ARA; ARA= 24.28±9.22, 25.80± 10.98), drawn with posterior tangents at C2-7; in the Cobb angles at C1-7 (47.61±12.76, 50.00±12.64) and C2-7 (20.52±11.25, 21.57±9.38); and in the head protrusion distances measured at C1 and C2 (eg, Tz^{C1-T1})(Table 3).

Table 3. Control Group (n=21) Average Lateral Cervical Radiographic Measurement Comparisons

Variable	Preradiographic (Mean±SD)	Postradiographic (Mean±SD)	Change (Post−Pre)
Tz^{C1-T1} (mm)	1.95±11.53	0.38±8.48	-1.57±7.86
Tz^{C2-C7} (mm)	11.61±10.64	9.52±7.87	-2.09±6.53
RRA C2-C3	5.76±3.31	7.33±3.85	1.57±3.86
RRA C3-C4	3.66±2.81	4.33±2.83	0.66±2.79
RRA C4-C5	4.90±3.38	4.47±3.32	-0.42±3.96
RRA C5-C6	3.71±2.53	3.80±4.67	0.09±4.40
RRA C6-C7	6.23±3.25	5.80±3.68	-0.42±3.27
ARA C2-C7	24.28±9.22	25.80±10.98	1.52±11.08
Cobb C1-C7	47.61±12.76	50.00±12.64	2.38±15.76
Cobb C2-C7	20.52±11.25	21.57±9.38	1.04±12.72

* : Two-sided paired t test.

Tz, Horizontal distance of C1 posterior-superior body corner to posterior-inferior of T1 or horizontal distance of C2 posterior-superior body corner to posterior-inferior of C7 ; RRA, segmental angle formed by posterior vertebral body tangents ; ARA, total curve angle from C2 to C7 formed by posterior vertebral body tangents; Cobb angle C1-C7, line through C1 arches to inferior endplate of C7 ; Cobb angle C2-C7, line on inferior endplate of C2 to inferior endplate of C7.

For the deep acupuncture treatment group, all radiographic angle measurements showed no statistically significant change to an increased lordosis, except for the segmental angle at C4-5(P=0.0076). The significant increases in lordosis were found in the segmental angles from posterior tangents at C4-5(2.55±3.58°). On average, the global angles statistically significant increased (ARA C2-7 = 9.33±15.66°, Cobb C2-7 = 5.77±10.32°). The largest increases in lordosis were found in the mid cervical spine (C2-C3 = 1.55±5.56, C3-C4 = 1.22±4.12, C4-C5 = 2.55± 3.58, C5-C6 = 2.11±4.54, C6-C7 = 1.72±5.19). On average, the global angles increased between 3°and 9°(ARAC2-C7 = 9.33±15.66°, Cobb C2-C7 = 2.94±14.2°, and Cobb C1-C7 = 5.77± 10.32°). Head protrusion reduced(Tz^{C1-T1} = 3.52±8.68°,Tz^{C2-C7} = 3.16±7.61)(Table 4).

Table 4. Treatment Group (n=18) Average Lateral Cervical Radiographic Measurement Comparisons

Variable	Preradiographic (Mean±SD)	Postradiographic (Mean±SD)	Change (Post−Pre)
Tz^{C1-T1} (mm)	5.61±7.62	2.08±7.33	-3.52±8.68
Tz^{C2-C7} (mm)	15.00±7.81	11.83±6.76	-3.16±7.61
RRA C2-C3	6.50±4.65	8.05±3.62	1.55±5.56
RRA C3-C4	2.94±3.84	4.16±2.66	1.22±4.12
RRA C4-C5	2.61±3.74	5.16±3.22	2.55±3.58#
RRA C5-C6	4.16±4.69	6.27±4.95	2.11±4.54
RRA C6-C7	4.61±4.60	6.33±4.10	1.72±5.19
ARA C2-C7	20.66±17.51	30.00±12.18	9.33±15.66##
Cobb C1-C7	44.22±16.10	47.16±13.67	2.94±14.21
Cobb C2-C7	15.61±14.09	21.38±12.65	5.77±10.32##

* : Two-sided paired t test.

Tz, Horizontal distance of C1 posterior-superior body corner to posterior-inferior of T1 or horizontal distance of C2 posterior-superior body corner to posterior-inferior of C7 ; RRA, segmental angle formed by posterior vertebral body tangents ; ARA, total curve angle from C2 to C7 formed by posterior vertebral body tangents ; Cobb angle C1-C7, line through C1 arches to inferior endplate of C7 ; Cobb angle C2-C7, line on inferior endplate of C2 to inferior endplate of C7.

: 0.001, ## : 0.05.

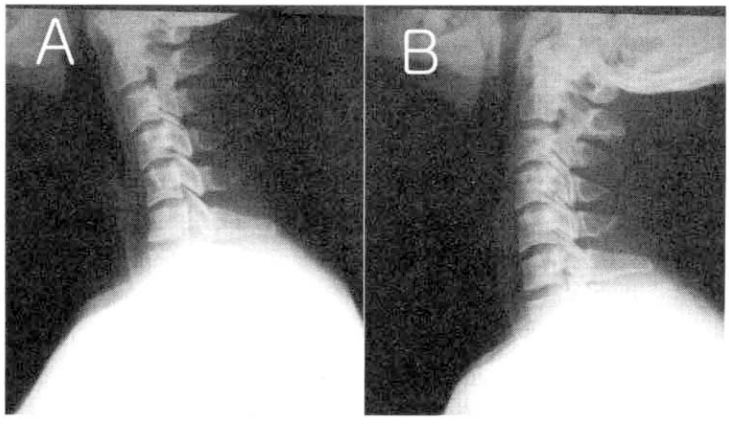

Fig. 2. Example patient with kyphosis who had a return to lordosis at follow-up. (A) The patient's lateral cervical radiograph depicts a kyphotic configuration. (B) After 3 weeks(7visits) of a deep acupuncture treatment, the configuration is lordotic

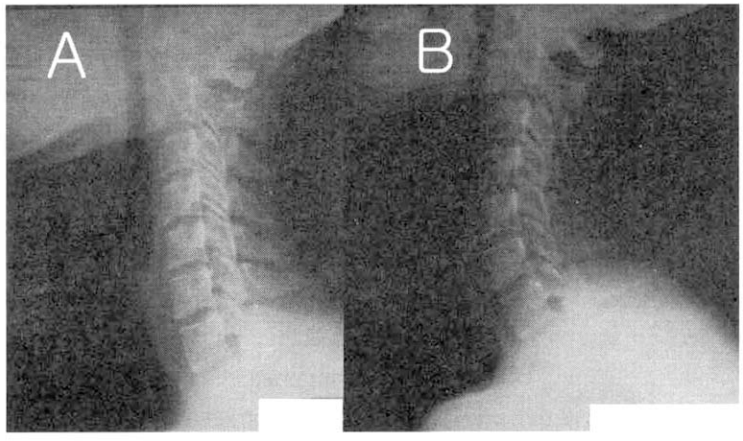

Fig. 3. Example patient with decreased lordosis who had a return to lordosis at follow-up. (A) The patient's lateral cervical radiograph depict a decreased lordotic configuration. (B) After 25 days(8visits) of deep acupuncture treatment, the configuration is lordotic

Fig. 2 and Fig. 3 demonstrate 2 cases with increased cervical lordosis after deep acupuncture treatment.

IV. Discussion

Neck pain is a common musculoskeletal symptom. It is estimated that in the general population the point prevalence for neck pain varies between 9.5% and 22%[16]. Neck pain is becoming increasingly prevalent in today's society[1].

The neck is a complicated structure containing several joints with capsules, discs, ligaments, fasciae and muscles, all of which may become hypersensitive to loading in conditions of pain.

Neck pain has multiple causes including tumor, infection, trauma, spinal degeneration, and mechanical factors. Concerning mechanical factors, pain may arise directly from painful muscles during contraction, or forceful muscle contraction may provoke pain from deep joint structures due to increased mechanical stress. Most patients tend to locate pain in the muscles in the back of the neck.

Jordan et al.[17] and Chiu and Lo[18] found significant reductions of isometric strength in both flexor and extensor muscles of the neck in patients with chronic neck pain compared to healthy controls and recently Ylinen et al.[19] found weakness also in rotator muscles.

In addtion, Revel et al.[20] reported that not only neck injury but also neck pain and muscle tension can alter the sensitivity of neck proprioception. The small intrinsic, deep dorsal and suboccipital cervical muscles show a high density of muscle spindles[21] that are likely to provide the main contribution to neck proprioception[22].

Cervical lordosis is caused by posterior wedging of the cervical disks[23] and is necessary for

proper spinal coupling[24].

Besides the fact that the cervical lordosis is formed in utero, the necessity of a normal cervical lordosis is supported by a wide array of studies. The current Index Medicus literature indicates that neck pain, headaches, surgical cases, rehabilitative treatments, whiplash, and incidences of degeneration all point to the relevance of the cervical curve as an important outcome of care[3-7,23].

While there is discussion as to the importance of this curve and as to the need for treatment, it is clear that there is significant interest in this area. However, the literature appears to show mixed results regarding the outcomes of various treatment procedures when viewed as to their effect on the cervical lordosis[8].

The altered configuration of the cervical lordosis in this experimental study, conducted 60 years ago, strongly indicates that this pattern was due to increased muscle activity of the superficial torque-producing muscles and the incapability of the tonic deep segmental cervical muscles to maintain the cervical alignment under such great load conditions. One explanation for the altered configuration of the cervical lordosis in patients with WAD may therefore be muscle imbalance due to overactive superficial muscle and/or the diminished holding capacity of the deep cervical muscles[24].

Cumulative evidence suggests that the deeper muscles are better suited to producing fine graded reflex mediated muscle stiffness than the more superficial muscles[25].

The main function of the neck muscles is to support and move the cervical column and head, postoperative cervical lordosis would seem to be preserved through dynamic factors such as muscles or ligaments[27].

It was hypothesized that deep acupuncture would increase holding capacity of the deep cervical muscles and thereby restore cervical lordosis or increase the curvature in neck pain patients who had loss their cervical lordosis.

There has been interest in the effect of chiropractic care on the cervical lordosis[9,27]. Some authors have demonstrated improvement in the magnitude of cervical lordosis with chiropractic adjustment alone[10,28-29], although it has been proposed that the quality and caliber of these studies may be somewhat suspect[8]. Conservative methods to restore or improve cervical lordosis are rare, with review of the literature locating only 2 chiropractic biophysics (CBP) studies demonstrating significant improvement in lordosis following treatment with 2 different types of cervical extension traction[9,15,23].

There were very few high validity trials supporting the efficacy of acupuncture. and With acupuncture for chronic neck pain, we found that the most valid trials tended to be negative[12]. Systematic reviews have shown that the results of acupuncture trials have not provided evidence for the efficacy of acupuncture in the treatment of chronic neck pain[11-12].

The eighteen subjects who received deep acupuncture treatment were compared with the twenty one controls who did not receive treatment.

We found no statistically significant differences between the 2 groups when comparing sex, age, and pretreatment VAS scores. but the

pretreatment VAS and posttreatment VAS ((6.91±0.63 vs 6.87±1.02) scores for the control group were not statistically significant, there was, however, a statistically significant difference (P< .0001) for VAS scores in the deep acupuncture treatment group (7.40±1.06 vs 3.53± 1.27).

For the control group, no statistically significant differences existed in posterior tangents angles, the global absolute rotation angle, the Cobb angles and the head protrusion distances. But For the deep acupuncture treatment group, the significant increases in lordosis were found in the segmental angles from posterior tangents at C4-5(2.55±3.58°). and the global angles statistically significant increased (ARA C2-7 = 9.33±15.66°, Cobb C2-7 = 5.77±10.32°).

lordosis for neck pain subjects. Average global angle improvement in the treatment group between C2 and C7 posterior tangent lines was 9.33±15.66°, in Cobb angles at C1-C7 and C2-C7, the improvements were 2.94±14.21°and 5.77±10.32°.

The increases in posterior tangents at C4-5, ARA C2-C7 and Cobb angles at C2-C7 support our hypothesis of improved lordosis with deep acupuncture treatment. This is in contrast to no change in our control group subjects[15].

Due to the design of this nonrandomized study, it is unknown if the improvement in the patients cervicogenic pain was caused by the improvement in sagittal plane alignment of the cervical spine. Future nonrandomized and randomized projects should address this issue.

V. Conclusion

After deep acupuncture treatment in 18 cervical pain subjects, we found statistically significant changes in pain scales(VAS) and lateral cervical radiographic measurements compared with no change in 21 neck pain controls. For control subjects, we found no statistically or clinically significant differences for beginning and follow-up radiographic measurements at a mean of 15.14±8.52 months, indicating the repeatability of radiographic positioning, radiographic line drawing analysis, and sagittal cervical posture.

Deep acupuncture treatment on cervical region produced statistically significant and clinically significant increases in cervical

VI. Reference

1. Bovim G, Schrader H, Sand T. Neck pain in the general population. Spine. 1994 ; 19 : 1307-9.
2. Andersson GBJ. The epidemiology of spinal disorders. In : Frymoyer JW, ed. The adult spine : principles and practice. Philadelphia, PA : Lippincott Raven. 1997 : 130-41.
3. Katsuura A, Kukuda S, Imanaka T, Miyamoto K, Kanemoto M. Anterior cervical plate used in degenerative disease can maintain cervical lordosis. J Spinal Disord. 1996 ; 9 : 470-6.
4. Kawakami M, Tamaki T, Yoshida M, et al. Axial symptoms and cervical alignments after cervical anterior spinal fusion for patients

with cervical myelopathy. J Spinal Disord. 1999 ; 12 : 50-6.
5. Bagnall KM, Harris PF, Jones PRM. A radiographic study of the human fetal spine. I. The development of the secondary cervical curvature. J Anat. 1977 ; 123 : 777-82.
6. Matsunaga S, Sakou T, Sunahara N, Oonishi T, Maeda S, Nakanisi K. Biomechanical analysis of buckling alignment of the cervical spine. Spine. 1997 ; 22 : 765-71.
7. Nagasawa A, Sakakibara T, Takahashi A. Roentgenographic findings of the cervical spine in tension-type headache. Headache. 1993 ; 33 : 90-5.
8. Troyanovich SJ, Harrison DD, Harrison DE. A review of the validity, reliability, and clinical effectiveness of chiropractic methods employed to restore or rehabilitate cervical lordosis. Chiropr Tech. 1998 ; 10 : 1-7.
9. Harrison DD, Jackson BL, Troyanovich SJ, Robertson GA, DeGeorge D, Barker WF. The efficacy of cervical extensioncompression traction combined with diversified manipulation and drop table adjustments in the rehabilitation of cervical lordosis. J Manipulative Physiol Ther. 1994 ; 17 : 454-64.
10. Wallace HL, Jahner S, Buckle K, Desai N. The relationship of changes in cervical curvature to visual analog scale, neck disability index scores and pressure algometry in patients with neck pain. Chiropractic : J Chiropr Res Clin Invest. 1994 ; 9 : 19-23.
11. White AR, Ernst E. A systematic review of randomized controlled trials of acupuncture for neck pain. Rheumatology. 1999 ; 38 : 143-7.
12. Smith LA, Oldman AD, McQuay HJ, Moore RA. Teasing apart quality and validity in systematic reviews : an example from acupuncture trials in chronic neck and back pain. Pain. 2000 ; 86 : 119-32.
13. Dok Ho Kim. Acupuncture & moxibustion, the Research institute of oriental medicine, Inc. 1987 : 425-31.
14. Peng L, Cooke MS. Fifteen-year reproducibility of natural head posture : a longitudinal study. Am J Orthod Dentofacial Orthop. 1999 ; 116 : 82-5.
15. Harrison DE, Harrison DD, Joeseph J, Janik TJ, et al. Increasing the cervical lordosis with chiropractic biophysics seated combined extension-compression and transverse load cervical traction with cervical manipulation : nonrandomized clinical control trial, Journal of Manipulative and Physiological Therapeutics. 2003 ; 26(3) : 139-51.
16. Cote P, Cassidy JD, Carroll L. The Saskatchewan health and back pain survey : the prevalence of neck pain and related disorders in Saskatchewan adults. Spine. 1998 ; 23 : 1689-98.
17. Jordan A, Mehlsen J. Cervicobrachial syndrome and neck muscle function ; effects of rehabilitation. J Musculoskelet Pain. 1993 ; 1 : 283-8.
18. Chiu TT, Lo SK. Evaluation of cervical range of motion and isometric neck muscle strength : reliability and validity. Clin Rehabil. 2002 ; 16 : 851-8.
19. Ylinen J, Savolainen S, Airaksinen O, Kautiainen H, Salo P, Hakkinen A. Decreased strength and mobility in patients after anterior cervical diskectomy compared with healthy subjects. Arch Phys Med Rehabil. 2003 ; 84 : 1043-7.

20. Revel, M., Minguet, M., Gregory, P., Vaillant, J., Manuel, J.L.. Changes in cervicocephalic kinesthesia after a proprioceptive rehabilitation program in patients with neck pain : a randomized controlled study. Arch. Phys. Med. Rehabil. 1994 ; 75 : 895-9.
21. Richmond, F.J.R., Bakker, D.A.. Anatomical organization and sensory receptor content of soft tissues surrounding upper cervical vertebrae in the cat. J. Neurophysiol. 1982 ; 48 : 49-61.
22. Rix, G.D., Bagust, J.. Cervicocephalic kinesthetic sensibility in patients with chronic, nontraumatic cervical spine pain. Arch. Phys. Med. Rehabil. 2001 ; 82 : 911-9.
23. Harrison DE, Harrison DD, Janik TJ, Jones EW, Cailliet R, Normand M. Comparison of axial and flexural stresses in lordosis and three buckled modes in the cervical spine. Clin Biomech(Bristol, Avon). 2001 ; 16 : 276-84.
24. Kristjansson E. Reliability of ultrasonography for the cervical multifidus muscle in, asymptomatic and symptomatic subjects, Manual Therapy 2004 ; 9 : 83-8.
25. Sj. olander P, Johansson H, Djupsj. obacka M. Spinal and supraspinal effects of activity in ligament afferents. Journal of Electromyography and Kinesilogy. 2002 ; 12 : 167-76.
26. Takeshi Maeda,Takeshi Arizono, et al. Cervical Alignment, Range of Motion, and Instability After Cervical Laminoplasty, CLINICAL ORTHOPAEDICS AND RELATED RESEARCH. 2002 ; 40, 132-8.
27. Plaugher G, Cremata EE, Phillips RB. A retrospective consecutive case analysis of pretreatment and comparative static radiological parameters following chiropractic adjustments. J Manipulative Physiol Ther. 1990 ; 13 : 498-506.
28. Leach RA. An evaluation of the effect of chiropractic manipulative therapy on hypolordosis of the cervical spine. J Manipulative Physiol Ther. 1983 ; 6 : 17-23.
29. McAlpine JE. Subluxation induced cervical myelopathy : a pilot study. Chiropr Res J. 1991 ; 2 : 7-22.