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Original Research Article

Effect of Craniocervical Flexion Training in Mechanical Neck Pain on Proprioception, Endurance and Pain - An Interventional Study

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ABSTRACT

Background: Cleland et al. (2005) defined mechanical neck pain as non-specific pain in the area of the cervico-thoracic junction that is exacerbated by neck movements. DCFs training which aims to enhance activation of the DCFs and restore coordination between the deep and superficial cervical flexors, is one form of exercise that has been advocated for addressing impaired neuromuscular control of the cervical flexors.

Objective: To find out effect of craniocervical flexion training in mechanical neck pain.

Methodology: An interventional study was conducted on 26 patients, who were randomly allocated into two groups, group A was an interventional group, who received craniocervical flexion training along with conventional exercises, and group B was a control group, received conventional exercises. Both males and females, with age between 30-50 years were included. Treatment was given for 4weeks,4 sessions per week. Data was taken at baseline and at the end of 4 weeks.

Results: Within group analysis was done by Wilcoxon sign ranked test and between group analysis was done by Mann-Whitney U test. There was significant improvement in NPRS, PPI and cervical proprioception in both the groups, ($p<0.05$). In interventional group there was significantly more improvement in PPI than conventional group,($p<0.05$).

Conclusion: Craniocervical flexion training is effective for improving deep cervical flexors endurance in mechanical neck pain.

Key words: Mechanical neck pain, craniocervical flexion training, endurance, proprioception.

INTRODUCTION

Neck pain is defined as, pain perceived as arising from anywhere within the region bounded superiorly by the superior nuchal line, inferiorly by an imaginary transverse line through the tip of 1st thoracic spinous process and laterally by the sagittal planes tangential to the lateral border of the neck. [1] Mechanical neck pain is defined as generalized neck and/or shoulder pain with mechanical characteristics including, symptoms provoked by maintained neck postures or by movement or by palpation of the cervical muscles. [2] Neck pain ranked the 4th greatest contributor to global disability and 21st in terms of overall burden, the prevalence was higher in women than in men, with a peak prevalence at about 45 years of age. [3]

In most cases, the pathologic basis for the neck pain is unclear and the complaints are labelled as nonspecific or mechanical. [4] Mechanical neck pain commonly arises insidiously and is generally multifactorial in origin, such as, poor posture, anxiety, depression, neck strain, sporting or occupational activity. [5,6]

Punjabi et al. estimated that the neck musculature contributes to 80% to the mechanical stability to cervical spine while the osteoligamentous system contributes the remaining 20%. [7] The logus colli is the principal muscle to support and control the cervical curve against the tendency toward buckling of the spine induced by the head weight and with the contraction of the powerful extensor muscles. [7,8]

Craniocervical flexion is the principal action of the deep cervical flexor muscles- longus capitis, longus colli (superior portion) & rectus capitis anterior that structurally support cervical motion segments. Hence, CCF muscle training is recommended clinically for the management of neck pain. [9]

Cervical proprioception is the sense of position of head or neck in space, describing the complex interaction between afferent and efferent receptors to monitor the position and movement. [10] Muscle spindle are accepted as being the primary cervical receptors responsible for position sense and are coupled to supplementary afferent input from the cutaneous and joint receptors. [7,8,11] Many neck muscles have certain number of muscle spindles per unit, so it can be assumed that the muscles are requested to have high-level function of proprioception. [12] Boyd-Clark et al. [13] reported that the longus colli has the higher distribution rate of muscle spindle than the multifidus muscle, so the roles of longus colli in postural stability has been more emphasized recently So, improvement of muscle spindle function is translated to improved cervical proprioception. DCFs training which aims to enhance activation of the DCFs and restore coordination between the deep and superficial cervical flexors, is one form of exercise that has been advocated for addressing impaired neuromuscular control of the cervical flexors.The CCFT is performed with the patient in supine crook lying with the neck in a neutral position, such that the line of the face is horizontal and a line bisecting the neck longitudinally is horizontal to the testing surface. Layers of towel may be placed under the head if necessary, to achieve a neutral position. The uninflated pressure sensor is placed behind the neck so that it abuts the occiput and is inflated to a stable baseline pressure of 20 mm Hg, a standard pressure sufficient to fill the space between the testing surface and the neck but not push the neck into a lordosis. The device provides the feedback and direction to the patient to perform the required five stages of the test. The movement is performed gently and slowly as a head nodding action (as if saying "yes"). The CCFT tests the activation and endurance of the deep cervical flexors in progressive inner range positions as the patient attempts to sequentially target five, 2-mm Hg progressive pressure increases from the baseline of 20 mm Hg to a maximum of 30 mm Hg as well as to maintain a isometric contraction at the progressive pressures as an endurance task A performance index was calculated based on the number of times the patient could hold the pressure level achieved for 10 seconds. [14,15]

MATERIALS AND METHOD

It was an interventional study conducted at, physiotherapy college, Ahmedabad.

The study duration was, 4 weeks- 4 days per week. (16 sessions).

Sample size has been decided by the following equation:

$N=2SD^2 (Z_{\alpha/2}+Z_{\beta})^2/d^2$ [16,17]

Where,

SD= standard deviation (taken from referral study)

d=critical difference

$Z_{\alpha/2}$=level of significance, at 95%confidence interval the value is 1.96

Z_{β}=power of study

The study duration was long so, there was chances of drop out. Therefore, by taking 20% drop out risk the sample size was taken 26.

Patients were divided into two groups by simple random sampling technique by using chit method.

Group A: (interventional group): 13 patients

Group B (control group):13 patients.

Ethical approval: ethical approval was obtained by institutional ethical committee.

INCLUSION CRITERIA:

1. Pt's willingness to participate.
2. Both male and female subjects were included.
3. Age: 30-50 year.
4. Neck pain for> 3 months.

EXCLUSION CRITERIA:

1. Patient having any history of cervical spine surgery, or cervical trauma.
2. Patient having any pathological or neurological problem
3. Patient having giddiness
4. Vertebrobasilar insufficiency

Materials used in the study were:

Assessment form, Consent form, Numeric pain rating scale sheet, Pen, Pencil, Paper, (Stabilizer ™, Chattanooga Group Inc., Chattanooga, TN) pressure biofeedback, Plinth, Hot-pack, Sensa-move software (version 2.3), Chair, Bed sheet or towel, Dumbbells of different resistance.

Figure :1 materials used

OUTCOME MEASURES:

1.Numeric pain rating scale (NPRS): [18]

Pain intensity is measured on 11-point pain intensity numeric rating scale, the number that the respondent indicates on the scale to rate their pain intensity is recorded. Score range from 0-10, where 0 = no pain and 10 = worst possible pain.

Validity: for construct validity, the NPRS was shown to be highly correlated to the VAS in patients with rheumatic and other chronic pain condition (pain >6 months); correlation range from 0.86 to 0.95.

Reliability: test-retest reliability observed in both literate and illiterate patients with rheumatoid arthritis was r=0.96 and 0.95

2. Pressure performance index: [19,20]

A performance index can be used to document an objective measure. PPI shows endurance of deep neck flexor muscle. The (Stabilizer ™, Chattanooga Group Inc., Chattanooga, TN) pressure biofeedback is used for measuring PPI. Performance index was calculated based on the number of times the patient could hold the pressure level achieved for 10 seconds. The highest activation score was 10 mm Hg, and highest performance index, 100.

Reliability: ICC for 50 asymptomatic subjects was 0.93.

3.Cervical proprioception (sensa move version 2.3): proprioception isthe sense of position and motion that were delivered by receptors located deep in muscles, tendons and joints. [21]

There are two parts for measuring proprioception

1.in part one (with visual feedback), the patient has to move to a target point in one of the four direction flexion, extension, lt rotation and rt rotation, at a slightly randomized angle, at 80% of the maximum ROM in that direction.

2. in part two (without visual feedback, the patient has to move to the same target, but now without the help of the moving red dot on the screen.

Data recorded: the complete movement patterns of part 1 and part 2 are recorded. But at this stage only the part 2 data are used.

Data analysis and output:

The output of the proprioception measurement is the visualization of the movement pattern during part 2, and the computation of the difference to angle and in displacement between the actual movement towards the target without visual feedback (part 2) and the ideal straight and precise movement to the target.

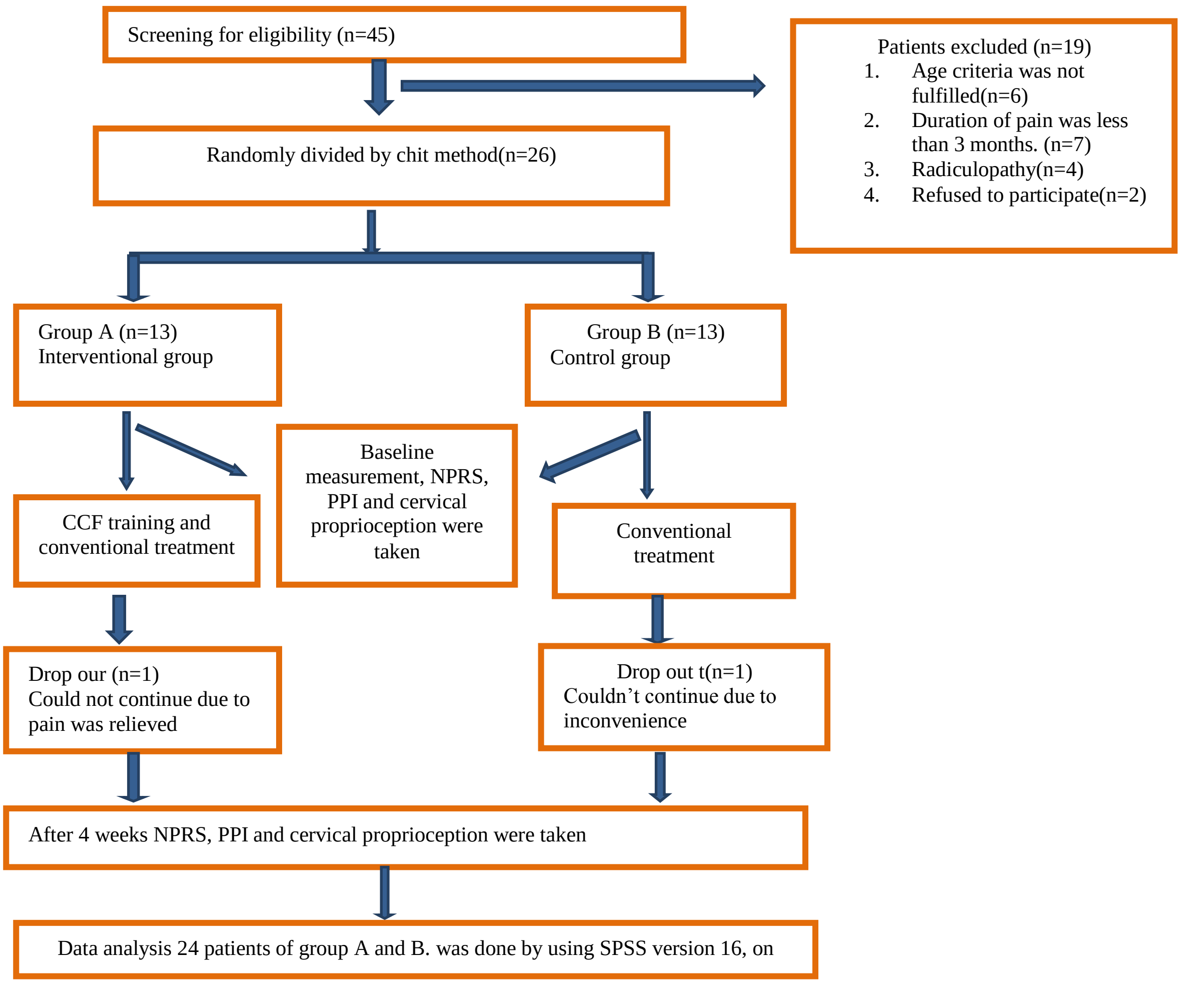
An angle difference (in degrees) showing the accuracy in direction (the smaller the difference the better) Reliability: in 20 older adults ICC for proprioception was 0.91, MDC was 3.18. [22]

PROCEDURE:

Ethical clearance was obtained from the institutional ethical committee for the study. Total 45 patients, who were referred from the orthopaedic OPD were screened for the eligibility from that, 26 patients who fulfilled the inclusion and exclusion criteria were included in the study.

The purpose and nature of the study was thoroughly explained to the patient. Patients were verbally described the procedures to be undertaken in the study. Written informed consent was obtained from all the patients. Patients were allocated randomly into two groups, group A and group B. On first visit, a complete assessment was done which included the descriptive data for age, sex, chief complain, past medical surgical history was documented. Pre intervention NPRS, PPI and cervical proprioception were taken at the first day. After completing four week of treatment, post intervention NPRS, PPI, and cervical proprioception were taken.

FLOW CHART OF STUDY PROCEDURE:



GROUP A: [23,24] **INTERVENTIONAL GROUP** (n=13) patients in the interventional group were given craniocervical flexion training along with conventional treatment.

Patient position: crook lying with the neck in a neutral position (no pillow) such that the line of the face is horizontal and a line bisecting the neck longitudinally is horizontal to the testing surface. Layers of towel may be placed under the head if necessary, to achieve a neutral position. The uninflated pressure sensor is placed behind the neck (3 folded) so that it abuts the occiput and is inflated to a stable baseline pressure of 20 mm Hg, a standard pressure sufficient to fill the space between the testing surface and the neck but not push the neck into a lordosis. The movement is performed gently and slowly as a head nodding action (as if saying “yes”). Increase the pressure on cuff to 22 mm Hg and ask the patient to hold pressure steady.

The final pressure was the one at which the patient could hold 10 sec for 10 repetition. At that pressure training was started for deep cervical flexor muscles,3 sets of 10 repetition. with 2min rest between each set.

Along with this all conventional exercise have been given.

Figure 2: craniocervical flexion training

GROUP B: CONVENTIONAL TREATMENT: [25]

1. HOT PACK: [26]

Patient position**:** prone lying

Hot pack should be covered in towel and place it over back of neck for10 minutes.

Figure 3: hot pack

2. Stretching of tight muscles**:** [20,27]

a. Pectoralis major stretching: sitting on a treatment table or mat, with the hands behind the head. Keel behind the patient and grasp the patient’s elbow. Have the patient breathe in as he or she brings the elbows out to the side. Hold the elbows at this endpoint as the patient breathes out. As the patient repeats the inhalation, again move the elbows up and out to the end of available range and hold as the patient breathes out

b. Pectoralis minor stretching**:** patient position: sitting, place one hand posterior to the scapula and other hand anterior on the shoulder just above the coracoid process .as the patient breathes in, tip the scapula posteriorly by pressing up and back against the coracoid process while pressing downward against the inferior angle the scapula; then hold it at end-position while the patient breathes out, repeat, readjusting the end-position with each inhalation and stabilizing as the patient exhales**.**

c. Upper trapezius stretching patient position and procedure: sitting with the ipsilateral hand behind the back to stabilize the scapula and the head rotated to the tight side. Stand behind the patient and apply the stretch by adding a combination of cervical flexion, further rotation to the tight side.

All stretching should be done for 30 sec hold for 3 repetitions.

3. Active neck and shoulder ROM exercises**:**

Patient position: sitting in chair with back supported, perform active movement in pain free range. Active neck ROM exercise was done 5 sets of 10 repetitions (flexion, extension and Lt side flexion and lt rotation), 2 min rest between each.

4. Isometric neck exercises for neck flexors, extensors, side flexors and rotators. Each done for 10 second hold for 10 repetitions.

Figure:4 isometric exercise for neck flexors.

Figure:5 isometric exercise for neck extensors

Figure:6 isometric exercise for neck side flexors

Figure:7 isometric exercise for neck Rotators

5.Scapular retraction:5 sets of 10 repetition.

6.Chin tucks**:** patient position and procedure: sitting or standing, with arms relaxed at the side look straight ahead with the ears directly over the shoulders. Place a middle or index finger on the chin, without moving finger pull the chin and head straight back until a good stretch is felt at base of head and top of neck. Hold for 10 sec. [28]

a. starting position **b.endingposition**

Figure :8 chin tucks

7. Middle and lower trapezius strengthening: [29]

a. starting position **b. ending position**

Figure:9 middle trapezius strengthening

a. starting position **b. ending position**

Figure:10 lower trapezius strengthening

RESULTS

Data of total 24 patients were analysed using SPSS version 16.

Total 26 patients were included in the study; 13 patients were given conventional treatment and 13 were given CCF training along with conventional treatment. Out of them 1 patient from conventional and 1 patient from interventional group were discontinued the treatment. So, total 24 patients, 12 from control and 12 from interventional group completed the study. Data analysis was performed on the following outcome measures:

1. Numeric pain rating scale score
2. Pressure performance index
3. Cervical proprioception

Data were analysed at baseline and after 4 weeks of treatment. Confidence interval was kept at 95% and level of significance was kept at 0.05.

Kolmogorov-Simonov test and **Shapiro-Wilk test** were applied to check whether the data follows normal distribution or not.

Baseline data was calculated by using Mann-Whitney test for age, gender, duration of pain, NPRS, PPI, cervical proprioception in flexion, extension, RT rotation, and LT rotation

Table 1: Baseline characteristics

variable	Group A (mean±sd)	Group B (mean±sd)	U value	Z value	p value (<0.05, significant)
Age	35.83±7.02	39.25±6.55	48	1.39	0.16
Gender	1.30±0.48	1.33±0.49	72	0.00	1.00
Duration of pain in months	13.92±16.22	16.75±20.54	67	0.29	0.77
NPRS	5.33±0.88	5.00±1.04	57	-0.90	0.36
PPI	22.08±8.63	24.66±1.27	68.50	-0.20	0.84
Pro. flex	8.35±3.69	8.25±4.01	70.50	-0.09	0.93
Pro.ext	4.87±2.18	5.71±1.36	54.5	-1.01	0.31
Pro.rt rot	5.81±2.65	6.31±1.75	54.5	-1.01	0.31
Pro lt rot	4.35±2.40	4.18±2.38	68	-0.23	0.82

So, all p values are more than 0.05, so accepting null hypothesis, suggesting that there was not significant difference in variables between two groups at baseline.

WITHIN GROUP ANALYSIS:

GROUP A: Interventional group

In interventional group analysis of pre and post NPRS, PPI, and cervical proprioception was done by using Wilcoxon sign ranked test, because the data was not normally distributed. There was significant difference ($p<0.05$) between pre and post treatment NPRS, PPI, and cervical proprioception score.

Table 2: Pre and post means of NPRS, PPI, cervical proprioception within group A

variable	Pre-Mean ± sd	Post Mean ± sd	Z-value	Significance p value (<0.05 =significant)
NPRS	5.33±0.88	2.25±0.96	-3.10	0.002
PPI	22.08±8.64	73.50±16.22	-3.06	0.002
Cer.fle.pro	8.35±3.69	5.14±2.25	-3.06	0.002
Cer.ext.pro	4.87±2.18	3.39±1.95	-2.31	0.021
Cer.rtrot.pro	5.8±2.65	3.75±2.43	-3.06	0.002
Cer.ltrot.pro	4.18±2.38	2.87±2.03	-2.19	0.034

GROUP B: Conventional group:

In conventional group analysis of pre and post NPRS, PPI, and cervical proprioception was done by using Wilcoxon sign ranked test.

Table 3: Pre and post means of NPRS, PPI, cervical proprioception within group B

Variable	Pre-Mean ± sd	Post Mean ± sd	Z value	Significance p value (<0.05 =significant)
NPRS	5.00±1.04	2.5±1.00	-3.11	0.002
PPI	24.66±1.27	61.50±2.05	-3.06	0.002
Cer.flex.pro	8.25±4.01	5.25±2.35	-2.82	0.005
Cer.ext.pro	5.71±1.36	4.64±2.42	-1.84	0.065
Cer.rt.rot.pro	6.31±1.75	3.90±1.75	-2.98	0.003
Cer.lt.rot.pro	4.18±2.38	3.35±2.31	-2.04	0.041

BETWEEN GROUP ANALYSIS:

For between group analyses Mann-Whitney U test has been applied.

Table 4: Pre-post mean difference of NPRS, PPI, and Cervical proprioception between groups A and B

Variable	GROUP A (pre-post difference) mean±sd	GROUP B (pre-post difference) mean±sd	Z-value	U-value	Significance (p value<0.05 =significant)
NPRS	3.08±0.79	2.50±1.00	-1.77	43.00	0.076
PPI	50.75±15.63	36.50±17.14	-2.11	35.50	**0.034**
Cer.fle.pro	3.21±1.82	2.92±2.69	-0.43	64.50	0.665
Cer.ext.pro	1.48±1.81	1.07±2.58	-0.17	69.00	0.862
Cer.rtrot.pro	2.06±1.30	2.40±1.37	-0.46	64.00	0.644
Cer.ltrot.pro	1.48±3.15	0.83±2.19	-1.09	53.00	0.272

So, the null hypothesis was accepted for pain and cervical proprioception and null hypothesis was rejected for deep cervical flexors endurance. So, there was significant difference between both the groups in deep neck flexors endurance.

DISCUSSION

The current study focused to show effectiveness of craniocervical flexion training on pain, endurance and proprioception in patients with mechanical neck pain. Total 26 patients of mechanical neck pain were divided into 2 groups,13 patients in each group. 13 patients in group A were administered conventional therapeutic exercise for neck pain and 13 patients in group B were administered craniocervical flexion training along with conventional therapeutic exercise. There was 1 drop out from each group, the treatment was given for 16 sessions in 4weeks. NPRS, PPI, and cervical proprioception were taken as outcome measures before & after the study in both the groups.

Results have been showed statistically significant improvement in pain, deep cervical flexor endurance and cervical proprioception [p<0.05], in both groups, after 4 weeks. But the improvement is more in interventional group. But this difference is not statistically significant between group except, PPI.

According to results of this study there is significant improvement in pain in both the groups.

D. Falla et al.2003 did a study to find out EMG activity of the deep cervical flexor muscles during performance of the CCF test in patient with neck pain on 10 patients with chronic neck pain and on 10 control concluded that, patients with neck pain use an altered muscle strategy to perform the craniocervical flexion task. The research indicates individual with neck pain have an inferior ability to increase and hold progressively inner range positions of craniocervical flexion, which reflect dysfunction of the deep cervical flexor muscles. [5] As, the craniocervical flexion training specifically targets deep cervical flexor muscles, the activation of deep cervical flexor muscles may reduce neck pain.

Jull et al, studied effect of low load craniocervical flexion exercise on cervicogenic headache patients, treatment duration was 6 weeks. The results showed that the treatment significantly reduce the pain associated with palpation and neck movements. [13]

This study has been shown significant improvement in deep cervical flexor endurance in both the groups but there was significantly more improvement in CCF training group. The improvement in craniocervical flexion training group can be explained on the basis of motor learning which requires proprioception as well as information from the external world. With biofeedback training the goal-oriented behaviour can be reinforced, thereby motor behaviour can be improved. Pressure biofeedback guided craniocervical flexion training may provide an external feedback to the patient regarding his performance of task. [6]

Finding of Wal et al. suggested that muscle strength increases could be due to an increase in the average firing rate, motor unit recruitment and increase synchronization of the active motor unit.

Several possible mechanisms may explain the improvements in proprioception following CCF training.

CCF training directly activates the deep cervical flexors musculature, according to Boyd-Clark et al.,2002 deep cervical flexors have a relatively high density of muscle spindles. [30] Thus, the repeated contractions involved in CCF training may improve muscle spindle function translating to improved cervical proprioception.

It is also possible that improved cervical neuromuscular control gained from CCF training could decrease stresses placed on the joints & other structures of the cervical regions. It has been suggested that abnormal joint stress may alter firing of cervical afferents with resultant changes in proprioceptive functions & scalene muscle activity is reduced and deep muscle activity is increased following CCF training & this may alter intersegmental kinematics leading to improved acuity for cervical movement. Proprioceptive acuity has been argued to both increase and decrease with muscle activity. Thus, changes in activity of the deep and superficial muscles may be responsible for changes in proprioception. [31]

G Jull, D Falla, et al studied the effect of two exercise regimes on retraining cervical joint position sense on 64 female patients, with chronic neck pain. Craniocervical flexion training was given as an intervention and proprioceptive exercises were given as conventional treatment for 6 weeks. They found significant improvement in JPE in both the group.

Between group analysis suggested that there was no significant difference in pain and cervical proprioception in group A and group B, but there was significant difference in deep cervical flexor endurance(PPI).

Limitations:

Small sample size

Long-time follow up was not taken.

Clinical Implication:

The craniocervical flexion training can be effective for improving deep neck flexor endurance

Future Recommendation:

This study can be done on large sample size.

Long term follow -up of subjects should be taken to check the sustainability of the effect of CCFT.

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