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Effect of Cervical Traction on Cardiovascular Status of Healthy Young Men

Shimpachiro Ogiwara

ABSTRACT

The purpose of this study was to determine the cardiovascular response to different external loads applied during continuous cervical traction in the sitting position and whether the same physiological response would occur if different external loads were applied during intermittent cervical traction in both the supine and sitting positions. Sixty volunteers' cardiovascular response was monitored and measured in the sitting and supine (control) positions under two experimental conditions of continuous and intermittent cervical traction with a tractive force of 4.0kg and 13.0kg. With an automated non-invasive method, the author measured the participant's systolic blood pressure, diastolic blood pressure, mean arterial blood pressure, heart rate, and rate-pressure product. In comparing the baseline data for the sitting and supine positions, there was no significant difference in the variables of each experimental condition for both continuous and intermittent traction. There was, however, a significant difference in the cardiovascular response during cervical traction between the sitting and supine positions, suggesting that the cause was positional and not from the effect of cervical traction. The findings suggest that routine monitoring of blood pressure in young adult males with normal cardiovascular status may not be necessary during cervical traction treatment and that further studies be carried out to assess the effect of cervical traction on the cardiovascular status of clients with neck problems.

KEY WORDS

Cervical traction, Heart rate, Blood pressure, Rate-pressure product

INTRODUCTION

Cervical traction is a traditional physiotherapy modality for patients with symptoms resulting from pressure on nerve roots, whether this is due to disc protrusion, osteophytosis or cervical spine injury[1-4]. Although there have been some studies concerning the method of application (i.e., continuous vs. intermittent), patient's positioning, and tractive force[2,3,5], the immediate effect of cervical traction on the cardiovascular system has only recently been investigated by Balogun *et al*[6]. They monitored the healthy subjects' heart rate (HR), systolic pressure (SBP), diastolic pressure (DBP), mean arterial blood pressure (MBP), and rate-pressure product (RPP) during continuous traction in the supine position. Their study yielded a significant decrease in SBP, DBP, MBP, and RPP for conditions requiring a treatment with ten pounds or 4.53kilograms (kg), but not with 30 pounds or 13.59kg. In addition, 44 per cent (%) of their subjects experienced untoward reactions. One of the conclusions derived from their study was that the cardi-

Department of Physical Therapy, School of Allied Medical Professions, Kanazawa University

ovascular response be evaluated during cervical traction in the sitting position. Contrary to reports in which patients following cervical traction have experienced vertigo, nausea, and mild headache[7], the author rarely encountered such symptoms. Furthermore, in Japan, the majority of patients undergoing cervical traction are treated in the sitting position because of limited space available in the crowded physiotherapy departments of many hospitals. Thus, one of the purposes of this study was to determine the cardiovascular response to different external loads applied during continuous cervical traction in the sitting position. The other purpose was to determine if the same physiological response would occur in response to different external loads applied during intermittent cervical traction in both the supine and sitting positions. The null hypothesis was that no difference would be seen between the baseline cardiovascular measurements obtained in both the supine and sitting positions and those measurements taken during intermittent or continuous cervical traction treatments.

METHODS

1. Continuous cervical traction in sitting (Experiment 1)

1) Subjects

Twenty volunteers were randomly selected from a group of 60 male college students, each of whom had no history of a cardiovascular problem or cervical spine pathology. There were no statistically significant differences in age, height or body mass among the groups in Experiments 1, 2 and 3 (Table 1). None of the students was an elite athlete. The procedures and risks of the study were explained to the participants before the experiment took place, and they were asked to sign an informed consent sheet.

Table 1. Demographic data of subjects (mean±SD)

Experiment	n	Age (years)	Height (cm)	Mass (kg)
1	20	21.3±2.5	170.9±5.3	64.7±8.5
2	20	20.8±1.5	170.5±5.7	61.7±7.4
3	20	21.0±1.8	170.7±3.2	62.5±6.0

2) Experimental design

The investigator followed a repeated measure experimental design, the same design Balogun *et al*[6] used in their study, so that the results would be comparable to theirs. Specifically, the aim of this design was to compare a baseline physiological response with that of responses occurring during cervical traction while applying different tractive forces (kilogram weight). Using each participant as his own control, the investigator monitored the participants' cardiovascular response in the position of sitting (i.e., control condition) and under two experimental conditions (i.e., applying 4.0 and 13.0kg tractive forces) in both the sitting and supine positions. Although Balogun *et al* selected ten pounds or 4.53kg to reflect the lower tractive force recommended by Kisner and Colby[7], the investigator chose 4.0kg because the mechanized traction device could only precisely monitor a tractive force to the nearest round figure. In addition, the investigator justified 4.0kg instead of rounding it to the nearest whole number or 5kg because it is nearer to the lower limit of tractive force which is generally agreed to be 3.59kg[8]. Similarly, an upper limit of 13.0kg instead of 30 pounds or 13.59kg was selected for safety reasons and for reasons mentioned above, for this load is within the recommended tractive force necessary to separate the cervical vertebrae, as was demonstrated by Colachis *et al*[9]. Each participant wore loose clothing and completed the experiment in one session.

3) Instrumentation and procedure

Blood pressure was monitored over the brachial artery by a Blood Pressure Monitor for Exercise Testing STBP-680 (Nippon Colin Inc., 2007-1, Hayashi, Komaki, Aichi, Japan). This device simultaneously monitors the HR, and provides an "on-line" print-out of the SBP, DBP, HR and RPP (myocardiac oxygen consumption) and its reliability was acceptable for the purpose of this study[10-12]. Cervical traction was applied using a Tractizer New-2 mechanized traction unit (Minato Medical Science Inc., 13-11, Shin-Kitano 3, Yodogawa, Osaka, Japan) with a table and head halter. The traction device was calibrated beforehand. Having placed the participant in a sitting position the blood pressure cuff was secured around the right arm and the terminal connected to the STBP-680. A halter was applied with 25° to 35° of neck flexion[13] and snugly strapped to the participant's head and chin. The participant was instructed to hold an on-off switch connected to the traction unit so that he could terminate the experiment in case of any unpleasant reaction during the treatment.

The participant remained in a sitting position for five minutes during which a baseline level for the cardiovascular measure was established. The SBP, DBP, HR and RPP were measured every 60 seconds. Immediately following the termination of the fifth minute, the first continuous traction using either the 4.0 or 13.0kg weight was administered for a period of 10 minutes. On termination of traction, the unit was switched off and measurement of the recovery cardiovascular responses was taken every 60 seconds for a duration of five minutes. When the participant recovered to his initial baseline values, the investigator administered the alternative weight treatment. Again, the cardiovascular response was monitored every 60 seconds for five minutes following the treatment. The investigator randomised the order of the two experimental conditions applying 4.0 and 13.0kg tractive forces. During the recovery phase the participant was asked if he experienced any untoward reaction such as headache, dizziness, or other discomfort during the cervical traction.

2. Intermittent cervical traction in supine/sitting (Experiment 2)

Twenty volunteers were randomly selected from a group of the remaining 40 male college students. The demographic data of the participants are shown in Table 1. Instrumentation and procedure for Experiment 2 were the same as for Experiment 1, except that the intermittent traction was applied both in the supine and sitting positions. Specifically, the cervical traction was sustained for 15 seconds followed by five seconds of release, which was repeated for ten minutes. The order of the two positions was also randomised.

3. Continuous cervical traction in supine (Experiment 3)

As the results of Experiment 1 and 2 failed to reach statistical significance it compelled the investigator to carry out Experiment 3 which was an re-enactment of Balogun's study[6]. The remaining 20 participants were used, with their demographic data shown in Table 1. Instrumentation and procedure for Experiment 3 was the same as for Experiment 1, except that the continuous traction was applied in the supine position only.

4. Statistical Analysis

Upon completion of the data collection, the investigator calculated the cardiovascular responses for the resting, treatment, and recovery phases. For each aspect of the experiment (i.e., sitting or supine lying, 4.0kg, 13.0kg, and recovery phase), the investigator calculated the mean SBP, DBP, MBP, HR, and RPP for all the participants for each 60-second during the 10-minute experiment. For each participant, the investigator averaged the cardiovascular responses under experimental conditions during the five minutes in the sitting or supine resting period and for the 10-minute traction duration with 4.0 and 13.0kg. A one-way analysis of variance (ANOVA) with repeated measures was employed to determine if there was a significant difference in the cardiovascular response between the baseline sitting or supine resting response (i.e., control condition) and the two experimental (i.e., 4.0 and 13.0kg treatment) conditions. In addition, using the Student's test, a comparison was made between

Table 2. Mean and standard deviation and F-ratios for the cardiovascular response during continuous cervical traction with two experimental conditions in a sitting position

	Resting	4.0kg	13.0kg	F-ratio
SBP (mmHg)	121.6±11.7	119.2±10.9	119.2±10.4	0.15
DBP (mmHg)	72.6± 7.6	72.8± 7.4	73.8± 8.9	0.21
MBP (mmHg)	97.7± 9.0	96.2± 7.8	96.8± 8.4	0.21
HR (bpm)	77.8±12.3	74.9±10.9	76.9±12.6	0.23
RPP (×10²)	94.4±17.3	89.4±14.3	90.2±14.2	0.35

Abbreviations SBP : systolic blood pressure ;
DBP : diastolic blood pressure
MBP : mean arterial blood pressure ;
HR : heart rate
RPP : rate-pressure product

continuous and intermittent cervical traction in sitting and supine, and between supine and sitting positions with intermittent cervical traction. The statistical significance was set at $p < 0.05$.

The cardiovascular response was monitored during the recovery phase for safety reasons. Statistical analyses were not carried out to compare the recovery data with the control and experimental conditions.

RESULTS

1. Continuous cervical traction in sitting (Experiment 1) (Table 2)

None of the participants experienced any untoward reaction during and after the cervical traction. On average, all but the DBP decreased during traction, reattaining the initial lower-than-average value within five minutes of the recovery phase. Changes in some of the cardiovascular response were as follows:

1) Systolic blood pressure

In the 4.0kg condition, the SBP decreased to 118 millimetres of mercury (mmHg) after four minutes of traction with fluctuations thereafter, decreasing to 119mmHg for the first minute of the recovery phase, and abruptly increasing to 123mmHg by the fifth minute of the recovery phase. In the 13.0kg condition, the SBP sharply decreased to 117mmHg in the first four minutes, repeatedly fluctuating thereafter, with a slow decrease during the recovery phase.

2) Diastolic blood pressure

In the 4.0kg condition, repeated fluctuations ranging from 72 to 73.5mmHg was observed during the first five minutes of traction. The DBP abruptly increased to 78mmHg by the sixth minute, decreasing thereafter and increasing to 75mmHg following the first minute of the recovery phase. In the 13.0kg condition, an abrupt increase took place on both the third (76mmHg) and tenth (76.5mmHg) minute and the lowest value of 71mmHg was registered at the seventh minute during the traction.

3) Mean arterial blood pressure

In the 4.0kg condition, a sharp decrease to 91mmHg was registered following the second minute of traction with repeated slow fluctuations thereafter. In the 13.0kg condition, MBP decreased to 96mmHg from the third to fifth minutes of traction and increased to 98.5mmHg at the tenth minute with repeated slow fluctuations during the recovery phase. The average (±SD) MBP during the resting phase was 97.7 (±9.0)mmHg.

4) Heart rate

A slight increase or decrease was observed in both experimental conditions, though the rate was generally higher in the 13.0kg than for the 4.0kg condition.

5) Rate-pressure product

In the 4.0kg condition, decreased values ranging from 88 to 92 were obtained throughout the traction and recovery phases with slow

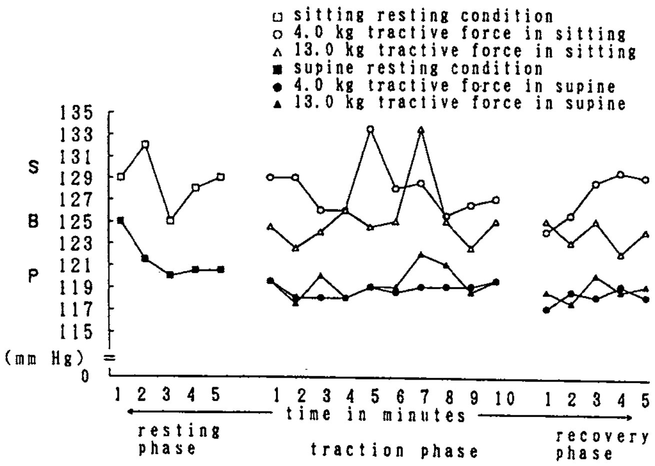

Fig. 1 Mean systolic blood pressure during intermittent cervical traction

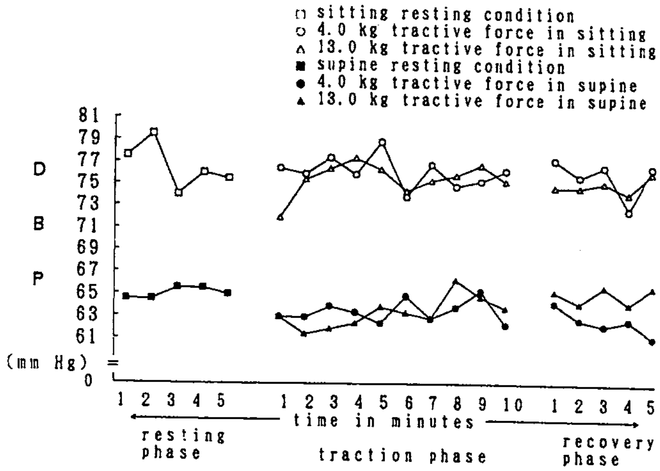

Fig. 2 Mean diastolic blood pressure during intermittent cervical traction

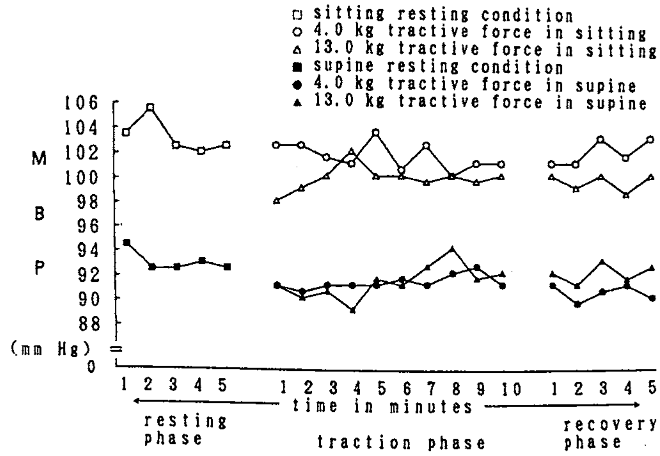

Fig. 3 Meanarterial blood pressure response during intermittent cervical traction

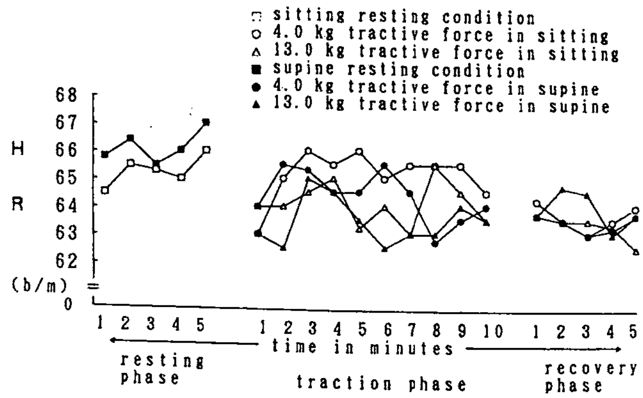

Fig. 4 Mean heart rate response during intermittent cervical traction

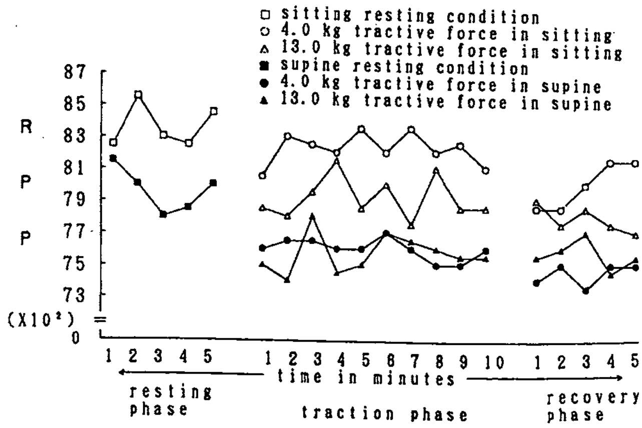

Fig. 5 Mean rate-pressure product response during intermittent cervical traction

fluctuations thereafter compared to the initial resting phase (92.5 to 97). In the 13.0kg condition, an abrupt decrease to 88.5 occurred at the end of the fourth minute of traction with repeated fluctuations thereafter, an increase to 94 after the tenth minute of traction was obtained and an abrupt decrease to 89.5 after the third minute of the recovery phase.

The results of ANOVA for the cardiovascular response showed no significant difference between that of the baseline sitting resting phase and the two experimental conditions (Data not shown).

2. Intermittent cervical traction in supine/sitting (Experiment 2)

None of the participants complained of any discomfort both during and following the experiment. All the cardiovascular responses fluctuated irregularly but within normal limits. There was no significant difference in all the responses between 4.0kg and 13.0kg traction stimuli in both sitting and supine positions

Table 3 Mean and standard deviation and F-ratios for the cardiovascular response during intermittent cervical traction with two experimental conditions in a sitting position

	Resting	4.0kg	13.0kg	F-ratio
SBP (mmHg)	129.5± 9.1	127.4± 7.3	124.3± 8.2	0.94
DBP (mmHg)	77.1± 8.0	76.2± 8.4	75.7± 7.9	0.02
MBP (mmHg)	103.3± 6.8	101.7± 6.2	100.1± 6.2	0.47
HR (bpm)	64.8±11.5	65.1± 9.4	64.2± 9.8	0.14
RPP ($\times 10^2$)	83.7±11.8	82.2±11.4	79.0±11.5	0.44

Abbreviations are the same as in Table 2.

Table 4 Mean and standard deviation and F-ratios for the cardiovascular response during intermittent cervical traction with two experimental conditions in a supine position

	Resting	4.0kg	13.0kg	F-ratio
SBP (mmHg)	121.4± 8.2	118.6± 6.8	119.1± 8.2	0.23
DBP (mmHg)	64.4± 8.1	63.7± 8.5	63.5± 9.2	0.17
MBP (mmHg)	93.2± 6.3	91.9± 6.2	91.3± 6.7	0.19
HR (bpm)	66.1±12.3	64.4±11.1	67.4±10.3	0.06
RPP ($\times 10^2$)	79.6±11.5	76.2±12.9	75.2±12.6	0.15

Abbreviations are the same as in Table 2.

during all phases of the experiment (Figures 1, 2, 3, 4 and 5). However, all but the HR in sitting for continuous traction were generally lower than those for intermittent traction with 4.0kg (Table 3), and, for 13.0kg both HR and RPP were generally higher with continuous traction. In comparing intermittent traction with Balogun's continuous traction[6], the latter's cardiovascular responses were generally lower than for the former (Table 4). Further, comparison of intermittent traction between that for the sitting and supine positions revealed that the former demonstrated a significantly higher cardiovascular response than the latter except for HR and RPP (Tables 3 and 4, $p<0.05$).

3) Continuous cervical traction in supine (Experiment 3)

All the parameters showed a similar trend as those in Experiment 1 and 2 failing to reach any significant difference in cardiovascular response between that for the 4.0 and 13.0kg during both the treatment and resting phase (Data not shown). Seven (35%) of the subjects experienced tension and/or pain in the neck during the cervical traction treatment, six of whom were on 13.0kg. The rest of the subjects had no complaints during and after the treatment.

DISSCUSSION

The findings from this study show that both continuous and intermittent cervical traction with a tractive force of 4.0kg and 13.0kg both in the sitting and supine positions did not affect the cardiovascular responses of the study population, hence acceptance of the null hypothesis. The results for both continuous traction in sitting and intermittent traction in sitting and supine differ from those of Balogun's[6] in which all the cardiovascular responses except HR were significantly lower during the 4.53kg traction in supine. This may be due to a tractive force of 0.53kg less in this experiment for the sitting position than for Balogun's of 4.53kg[6]. It may also be due to the fact that, in sitting, most of the tractive force is expended in supporting the head in an anti-gravity position resulting in insufficient stretching of the baroreceptors located in the carotid sinuses.

The subjects used in Balogun's study[6] were possibly questionable; they found significantly greater changes in respect to lesser traction stimulus, indicating that, despite the author's saying, they used "healthy subjects", their subjects had, in fact, "conditions requiring treatment". In other words, they might not have been healthy.

Anecdotal clinical evidence reports that some patients can tolerate a tractive force of up to 25kg in the sitting position without producing any untoward reaction. This may simply be due to habituation of the baroreceptor to stretching or cancellation of a decrease in the blood pressure with an increase in the blood pressure caused by stimulation of the cervical proprioceptors. Demonstration of significantly higher cardiovascular response for intermittent traction in the sitting than in the supine positions indicates that the heart simply has to work harder to pump blood to the upper body and head against gravity, consequently raising blood pressure, which is not a direct effect of cervical traction.

The results of Balogun's study[6] on continuous cervical traction in supine on 20 healthy subjects disclosed untoward reactions such as mild headaches in three (15%), "tension" in the neck following treatment in three (15%), mild dizziness in one (5%) when he sat up from lying on termination of the experiment, and "light-headedness" in one (5%) subject post-treatment. The latter two reactions can sometimes be experienced in any individual when he/she quickly rises from a supine position after a period of time. In the investigator's re-enactment of Balogun's study[6] or Experiment 3, five (25%) subjects experienced "tension" in the neck during cervical traction, four of whom were receiving a tractive force of 13.0kg. Since there was no such complaint from the subjects during intermittent cervical traction in the supine position, continuous cervical traction in supine with this amount of tractive force may simply have been too heavy for these subjects. Therefore, the application of such a tractive force may not be appropriate in some individuals, though, in theory, it is justifiable. It should also be noted that a tractive force of 13kg would not usually be applied in a clinical setting on a patient's first treatment, but graduated from eg. 7kg to 13kg over a period of treatments.

There were two differences in the subjects' characteristics between Balogun's and the present studies; the former included two females and in addition, the age of the former's subjects (mean : 27.0 ± 6.2 ; range : 20-39 years old) was significantly higher ($t : 4.23667$; $p < 0.01$) than that of the latter (see Table 1). These differences might have contributed to the difference in the results of the present study.

CONCLUSION

Routine monitoring of blood pressure in young adult males with normal cardiovascular status may not be necessary during cervical traction treatment. Further studies should be carried out on clients with cervical dysfunction.

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頚椎牽引における健常男子の心血管反応

荻　原　新八郎

要　旨

本実験の目的は，椅座位での頚椎持続牽引時に異なった牽引力による心血管反応を知ること，また仰臥位と椅座位での間歇牽引時にも同様の生理学的反応が起こるかどうかを知ることとした。健常男子大学生60名に対し，4.0kgと13.0kgの牽引力を用いた頚椎の持続・間歇牽引を椅座位と仰臥位で行い，最高血圧，最低血圧，平均血圧，心拍数，および二重積を運動負荷用血圧監視装置 STBP-680 で測定した。牽引時の頚椎前屈度は25°～30°とした。4.0kg牽引時において血圧の全般的な低下傾向が見られたものの，心血管反応に有意な変化は認められなかった。しかし椅座位での心血管反応は仰臥位のそれに比べると有意に高かったが，これは単なる姿勢による違いであろう。Balogun らの4.53kg牽引時の仰臥位持続牽引においては，心拍数を除いたすべての変数が有意に低かったが，彼らの対象者は健常ではなかった可能性がある。以上の所見から，「心血管系が正常な若年男子には頚椎牽引時に心血管反応をモニターする必要は無い」と結論づける。