

Lipid Profile of High Tetraplegia (Above C4) in Japan

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Abstract: **Objective:** To investigate whether the risk profile for coronary heart disease (CHD) is more favorable in individuals with high tetraplegia (neurological lesion above C4) than in healthy controls. (Because inactivity has a negative effect on the lipid profile.) **Design:** Case-control study. **Setting:** This research was performed in the rehabilitation hospital for the spinal cord injured persons. **Participants:** 19 healthy male controls (age-, height-, and body weight-matched) and 62 individuals with high tetraplegia (mean age 45.0 ± 17.35 years) with a mean time since injury of 16.9 ± 23.88 months were assessed the information was obtained from the 22 tetraplegics who had returned home from our hospital (all the other 40 left to other hospital), and recorded data on lipid values for comparison. **Interventions:** Not applicable. **Main outcome measures:** Total plasma cholesterol (TC), high-density lipoprotein cholesterol (HDL-C) and triglyceride (TG) concentrations were measured, and calculated the low-density lipoprotein cholesterol (LDL-C) concentration and the ratios of TC/HDL-C and LDL-C/HDL-C were calculated. **Results:** Significantly lower concentrations of TC, HDL-C and LDL-C were found in individuals with a SCI. However, no statistically significant difference was found between TC/HDL-C and LDL-C/HDL-C ratios of tetraplegic individuals and healthy controls. In individuals with high tetraplegia who were discharged home, HDL-C was still lower than normal control. **Conclusions:** Patients with high tetraplegia showed low HDL-C, but the TC/HDL-C and LDL-C/HDL-C ratios were normal.

Keywords: High tetraplegia, high-density lipoprotein cholesterol (HDL-C), lifestyle-induced disease.

INTRODUCTION

Today, persons with a spinal cord injury (SCI) live longer than in the past because of the improved therapeutic strategies for treating life-threatening complications, such as urinary tract infections and pressure sores, in these individuals. Therefore, management of these patients to avoid coronary heart disease (CHD) has become more important [1]. Previous studies have reported that persons with a SCI have lower concentrations of high-density lipoprotein cholesterol (HDL-C) than able-bodied persons. Subjects with a lesion level above C4 are included in some lipid studies. However, the data of these subjects were not analyzed separately for this group. The data belonged to the overall group of subjects with tetraplegia [2-5].

Doctors or nursing care managers who examine these persons with SCI must be aware of the importance of the prevention of lifestyle-induced disease, as one of the main causes of death in SCI is CHD [6]. It is thought that in individuals with high tetraplegia, HDL-C concentrations are lower than in tetraplegia below C5 or paraplegia because of the exercise limitation in high tetraplegics, due to the paresis itself. El-Sayed MS *et al.* [7] reported the effect of activity on HDL-C profile in persons with a SCI.

The objective of this study was to determine the serum lipid profile in individuals with high tetraplegia, and compare the result with the standard for the diagnosis of hyperlipidemia in Japan.

METHODS

Sixty-two male individuals were assessed with tetraplegia, admitted from January 1997 to December 2004, during their rehabilitation period in our center. All the patients had been bedridden until admission. The time since injury was 16.9 ± 23.88 months (range 2-132 months; Though the time since injury varies greatly, all of them had been admitted for rehabilitation for the 1st time). The mean age of the patients was 45.0 ± 17.35 years (range 17-80 years). Their mean BMI was 18.95 ± 3.62 kg/m². All were classified as having high tetraplegia (above C4), and the ASIA impairment scale indicated 41 (66%) complete (ASIA class A) and 21 (34%) incomplete (ASIA class B) injuries. Therefore all the patients had a motor complete lesion. Traffic accidents were the most common cause (40%) of SCI, followed by falls from a height 16 (26%), sports accidents 11 (18%) and falls 7 (11%), with three unknown (4%). None of the individual with tetraplegia had anemia or low albuminemia. Only 3 had diabetes mellitus (treated with insulin), 26 were smokers before, but not after their SCI. No one took medications that could affect their cholesterol levels.

Body length was measured to the nearest centimeter in a supine position and body weight was measured on a balance beam scale designed to accommodate wheelchairs.

Total cholesterol (TC), triglyceride (TG), and HDL-C concentrations were measured using enzymatic tests on the Hitachi 7450 automated analyzer (Japan). And glucose concentrations were measured. All participants were measured within 3 days from admission. Low density lipoprotein-cholesterol (LDL-C) in mg/dl was calculated according to the Friedewald equation [8] as follows: $LDL-C = TC - (HDL-C + TG/5)$.

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Among the 62 high tetraplegics, the relationship was investigated between body weight and serum cholesterol profiles in 22 patients who were discharged at home (the remaining 40 went to other hosp.), and obtained responses from 12 (55%). Individuals who went to home were supposed to have a changed lipid profile due to their meal. The average age of these 12 respondents was 31.3±14.13 years (range 17-58 years).

Data used was taken from physical examinations of 19 male staffs in our center in November 2005 as a control group. The control group with age-, height-, and body weight-matched to the subjects with a SCI. Their age was 49.2(SD 11.6) years, height was 1.69(0.063) meters, and body weight was 56.4(5.51) kg, mean BMI was 23.9(2.87) kg/m².

Statistics

A Welch’s t-test for independent samples was applied to detect differences between groups for subject characteristics and serum lipid profiles. Results were considered significant at $p \leq 0.05$.

RESULTS

The results of the comparison of demographic parameters in SCI patients and controls are shown in Table 1. TC, HDL-C, and LDL-C were significantly lower in those with SCIs. TC/HDL-C and LDL-C/HDL-C ratios were not significantly different between the two groups.

Table 1. Comparing between whole-SCIs and Healthy Control

	whole SCIs (n=62) Mean(SD)	healthy control (n=19) Mean(SD)	p-value
age(year)	45.0(17.35)	49.2(11.6)	N.S.
height(m)	1.69(0.077)	1.69(0.063)	N.S.
weight(kg)	54.4(11.50)	56.4(5.51)	N.S.
BMI(kg/m2)	18.95(3.62)	19.86(2.68)	N.S.
TC(mg/dl)	165.23(33.09)	204.79(35.70)	0.00019
HDL-C(mg/dl)	39.31(10.49)	52.84(13.54)	0.0006
TG(mg/dl)	105.42(48.11)	129(59.05)	N.S.
LDL-C(mg/dl)	105.20(28.15)	126.15(38.58)	0.043
Glucose(mg/dl)	92.96(25.05)	87.32(13.96)	N.S.
TC/HDL-C	4.48(1.35)	4.14(1.50)	N.S.
LDL-C/HDL-C	2.87(1.08)	2.60(1.38)	N.S.

Age-Related Factors

In Japan, spinal cord injuries are most prevalent among two age groups, those aged between 20 and 30 years (the ‘younger’ group) and those in their 60s (the ‘older’ group) [9], with this age distribution also true in our sample (Fig. 1).

The participants were divided into SCI-younger (under 45 years: the subjects’ mean age was 45 years) and SCI-older

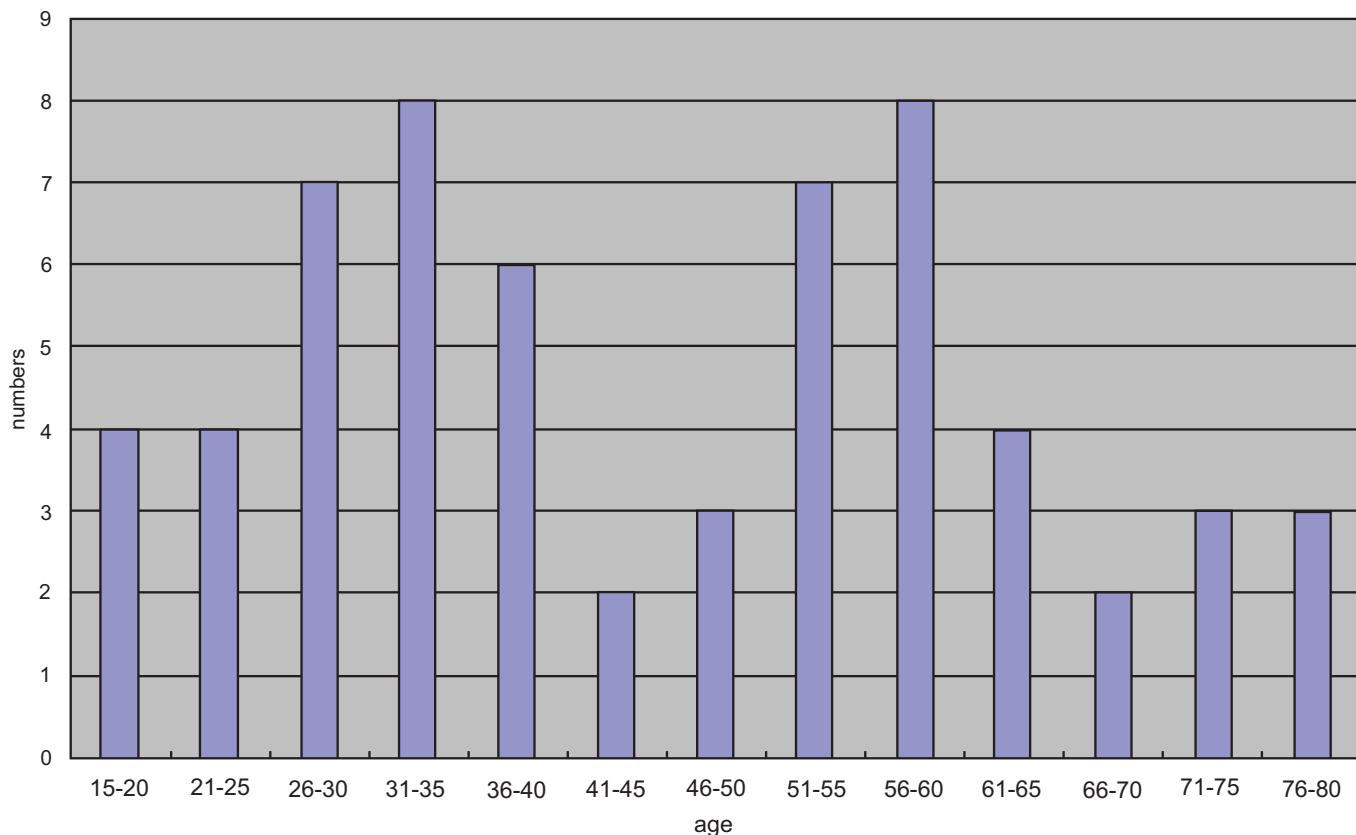


Fig. (1). Age distribution of tetraplegics.

(over 46 years), they were then compared with two corresponding control groups: control-younger (20-30 years) and control-older (60 years), with the results of this comparison shown in Tables 2 and 3.

Table 2. Comparing between SCI-Younger and Control-Younger

	SCI-younger (n=31) Mean(SD)	control-younger (n=7) Mean(SD)	p-value
age(year)	29.84(7.15)	34.71(1.70)	N.S.
height(m)	1.73(0.057)	1.73(0.055)	N.S.
weight(kg)	55.13(13.54)	52.81(4.88)	N.S.
BMI(kg/m2)	18.33(3.92)	17.48(1.63)	N.S.
TC(mg/dl)	157.06(31.18)	218.71(40.37)	0.0053
HDL-C(mg/dl)	38.12(11.24)	51.43(13.69)	0.046
TG(mg/dl)	103.87(52.02)	116.29(55.08)	N.S.
LDL-C(mg/dl)	95.53(32.25)	144.03(42.09)	0.023
Glucose(mg/dl)	87.79(18.52)	87.29(14.36)	N.S.
TC/HDL-C	4.37(1.49)	4.65(2.21)	N.S.
LDL-C/HDL-C	2.74(1.18)	3.12(1.93)	N.S.

Table 3. Comparing between SCI-Older and Control-Older

	SCI-older (n=31) Mean(SD)	control-older (n=12) Mean(SD)	p-value
age(year)	60.23(9.17)	57.7(2.74)	N.S.
height(m)	1.66(0.077)	1.67(0.057)	N.S.
weight(kg)	53.63(9.17)	58.4(4.89)	N.S.
BMI(kg/m2)	19.56(3.24)	21.25(2.14)	N.S.
TC(mg/dl)	173.39(33.41)	196.67(31.64)	0.045
HDL-C(mg/dl)	40.12(10.10)	53.67(13.99)	0.0081
TG(mg/dl)	106.97(44.67)	136.41(62.35)	N.S.
LDL-C(mg/dl)	111.77(23.43)	115.71(33.89)	N.S.
Glucose(mg/dl)	98.52(29.93)	87.33(14.37)	N.S.
TC/HDL-C	4.55(1.28)	3.85(1.03)	N.S.
LDL-C/HDL-C	2.96(1.02)	2.29(0.90)	N.S.

It was observed that TC, HDL-C, and LDL-C were significantly lower in the SCI-younger group than in the control-younger group.

Comparing the SCI-older and the control-older groups, it was found that TC and HDL-C were significantly lower in the SCI-older group than in the control-older group.

TC, TG, HDL-C, and LDL-C of individuals with tetraplegia living at home after being discharged from the hospital were not significantly different to those individuals that were compared with all the SCI individuals (TC 173.6(12.3) mg/dl, TG 104.4(55.9) mg/dl, HDL-C 41.0(14.1) mg/dl, LDL-C 111.4(33.8) mg/dl).

In 2002, the Japan Atherosclerosis Society issued 'Guidelines for Diagnosis and Treatment of Atherosclerotic Cardiovascular Diseases' (Table 4) [10], which proposed diagnostic reference values for serum lipids.

Table 4. The Guideline to Treat the Disease of Atherosclerosis (Japan Atherosclerosis Society)

hypercholesterolemia	TC	≥220 mg/dl
hyper low density lipoprotein-cholesterolemia	LDL-C	≥140 mg/dl
lower high density lipoprotein-cholesterolemia	HDL-C	<40 mg/dl
hypertriglyceridemia	TG	≥150 mg/dl

In the healthy controls in this study, average values for serum lipids did not fall beneath the normal limit proposed in the above guideline, but the average value of HDL-C over the whole group of persons with a SCI, as well as in the SCI-younger group, was less than this standard. In the SCI-older group, the HDL-C concentration was 40.12 mg/dl, which is very close to the limit of the normal value.

The number of persons agreeing with the guideline as a risk for atherosclerosis were 5 of SCIs in high TC (6 of control), 2 of SCIs in high LDL-C (4 of control), 22 of SCIs in low HDL-C (1 of control), and 11 of SCIs in high TG (7 of control).

DISCUSSION

In this study, the lipid profile of individuals with high tetraplegia was shown that TC, HDL-C, and LDL-C were lower than the healthy control. And, comparing to the 'Guidelines for Diagnosis and Treatment of Atherosclerotic Cardiovascular Diseases', TC and LDL-C were favorable, but HDL-C was unfavorable.

This tendency toward lower-than-normal levels of HDL-C is consistent with results of previous studies [11,12]. However, all such previous studies have involved individuals with paraplegia or quadriplegia (spinal injuries at or below the C5 level) who were able to operate a wheelchair without using their arms. This study is the first to focus on the serum lipid profile of high tetraplegia (above C4).

It was considered that the cause of a low HDL-C concentration with other lipid values within normal limits in individuals with tetraplegia, regardless of age, is not the limited amount of exercise that these individuals can perform due to their paresis [13]. Since HDL-C levels of the individuals with tetraplegia had similar levels as individuals with lower levels of a SCI. The factor contributing to this lipid profile may be the controlled hospital diet provided in the hospital prior to arrival at the medical center.

The main reason why the age distribution of persons with a SCI has two peaks in Japan, different from that in Europe and America where there is only one peak in younger patients, has been reported to be that young patients get injured in traffic

accidents, whereas older patients experience SCIs after incidents such as falls due to pre-existing cervical spondylosis. One cause of such pre-existing cervical spondylosis deformans is ossification of the posterior longitudinal ligament (OPLL). OPLL is thought to be correlated with the yellow races and is suggested to be associated with diabetes mellitus [14], but in this study, significantly no higher blood glucose levels were found either in the SCI-younger or SCI-older group than in the control group.

The TC/HDL-C and LDL-C/HDL-C ratios, strong predictors of CHD risk [15], did not differ significantly between the SCI group and the healthy control group. Though the time since injury was very broad in the subject group, there was no increased risk of CHD in the SCI group.

In this study, the low value of HDL-C persisted in the individuals who were discharged home from hospital. Forty patients were not followed up because they did not go home after being discharged from the hospital but were transferred to other medical institutes. This was because patients visited my hospital from many areas of the country and were then transferred to a variety of areas. Therefore, No data was available to compare lipid values between patients who went home after being discharged from the previous hospital and those who were transferred to other institutes.

Apstein *et al.* [16] examined the changes in serum lipid concentrations of patients with SCI following accidents. They described that HDL-C is markedly depressed following acute SCI and gradually returns toward normal by 1 year, and postulated that 44% of the increase in HDL-C is due to an increase in physical activity and 56% to the SCI itself.

However, in this study, HDL-C values did not increase in any of the participants after they returned home following discharge from hospital, even when they were studied individually. Further study would be necessary to clarify this point, because only a relatively small number of participants answered about their lipid profile at home, the ages of participants who answered varied greatly, and the times following injury or following discharge from hospital were also inconsistent.

Further studies would evaluate about other factors also contributing to CHD risk (such as diabetes mellitus, smoking, homocysteine, uric acid, ferritin, and creatinine).

CONCLUSIONS

In a Japan-based study, it was found that in individuals with high tetraplegia (above C4), TC, HDL-C, and LDL-C were significantly lower than in healthy controls, a finding consistent with previous studies conducted in tetraplegia below C5 and paraplegia. The TC/HDL-C and LDL-C/HDL-C ratios of high tetraplegia were within normal range. To conclude the incidence of CHD high tetraplegia must be evaluated with a larger sample and other variables.

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