

The Age Correlation of the Carotid Intima-Media Thickness According to Sex and Side in Asymptomatic Subjects

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Abstract-

Purpose: Reports concerning carotid intima-media thickness (CIMT) and linear correlation to age in healthy subjects did not distinguish the side and sex of the subjects. The purpose of this investigation attempts to clarify these issues.

Methods: 2402 asymptomatic persons, age 35-64, are separated into men's left (Lt) and right (Rt) and women's Lt and Rt carotid arteries for difference of CIMT between them and analysis of CIMT vs. age.

Results: There are significant difference between men's CIMT of Lt (CIMTML) vs. Rt (CIMTMR), women's Lt (CIMTWL) vs. Rt (CIMTWR), Lt side CIMT of men vs. women, and Rt side CIMT of men vs. women. The regression equation of CIMT vs. age for all four groups is determined.

Conclusion: We found an excellent linear correlation of CIMT to age and CIMT is significantly higher in men than women, so as higher in Lt than Rt. Further grouping of data into about 5-year period showed more clearly stepwise increasing of CIMT, so as the ratios of Lt CIMT different than Rt. CIMT study is served as highly efficient examination in therapy, prevention, clinic, or research survey about atherosclerosis and risk of stroke. Future study design concerning CIMT in separation groups of men and women, so as Lt and Rt is highly recommended.

Key Words: atherosclerosis, carotid intima-media thickness, neurosonology

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INTRODUCTION

Carotid dopscan examination has the advantage of convenience, non-invasiveness and well established association to the risks of thrombotic stroke⁽¹⁻³⁾. Thus carotid dopscan examination for atherosclerosis has been widely applied in daily practice of most neurologists, of basic examination package for health examina-

tion especially for people in middle aged and above, and is a main study tool for disease survey⁽⁴⁾.

Carotid intima-media thickness (CIMT) is known to be significantly different between left (Lt) and right (Rt) side of men and women^(5,6). Yet, there was lack of detail of CIMT data in different side of asymptomatic persons and the correlation of age to CIMT in separate groups of men and women and left and right in most previous

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study designs. The present investigation intends to clarify these issues.

METHODS

We collected a total of 2767 (1517 men and 1250 women) asymptomatic persons, age 35-75, who came to Eonway Health Maintenance Center, Western Garden Medicare Group for thorough health check, from Feb. 12, 2003 to Oct. 24, 2008. Those of age < 35 were not included in this study from beginning due to less clinical importance and lesser case numbers (No.).

The case No. of each age from 35-75 of men are about 13 to 47 from age 35 to 44, 37 to 65 from age 45 to 54, 23-67 from age 55 to 64, and 5-30 from age 65 to 75. The case No. of each age from 35-75 of women are about 13 to 40 from age 35 to 44, 39 to 90 from age 45 to 54, 17-55 from age 55 to 64, and 8-28 from age 65 to 75.

Those of age over 65 (including 65, same to below) were excluded due to the difference analysis showed that CIMT began up and down from age 65 and above in men and women (see Figure 1). A total numbers of 2402 (1323 men and 1079 women) asymptomatic persons, age 35-64, were included in this study.

B-mode ultrasonography was performed with a Toshiba SSA 6600A system equipped with a high resolution broadband transducer 7.5 MHz for detection of

CIMT in mm. All persons were examined by one experienced and highly consistent technologist using standard methods as previously mentioned⁽⁵⁾.

We divided these 2402 asymptomatic persons into four groups: 1323 CIMTML (men's Lt), 1323 CIMTMR (men's Rt), 1079 CIMTWL (women's Lt), and 1079 CIMTWR (women's Rt) for analysis of CIMT. Paired t-test was used for comparing between Lt and Rt CIMT of the same person. Two sample t-test was used for comparing between Lt CIMT of men and women and Rt CIMT of men and women. Regression equation was used in determination of mean CIMT of each age to age. The statistic software used for all analysis was Minitab 15.

RESULTS

The mean \pm SD of CIMT in each group is CIMTML 0.776 ± 0.110 mm, CIMTMR 0.768 ± 0.100 mm, CIWTWL 0.726 ± 0.088 mm, and CIMTWR 0.721 ± 0.087 mm. Table 1 shows significant difference between men's Lt and Rt and women's Lt and Rt and men's Lt and women's Lt and men's Rt and women's Rt with *p*-value of 0.000, 0.004, 0.000, and 0.000, accordingly.

The regression equation of CIMT to age of each group is CIMTML: $0.492 + 0.00561 \times \text{age}$, CIMTMR: $0.510 + 0.00511 \times \text{age}$, CIMTWL: $0.456 + 0.00538 \times \text{age}$, and CIMTWR: $0.440 + 0.00565 \times \text{age}$. Details of statisti-

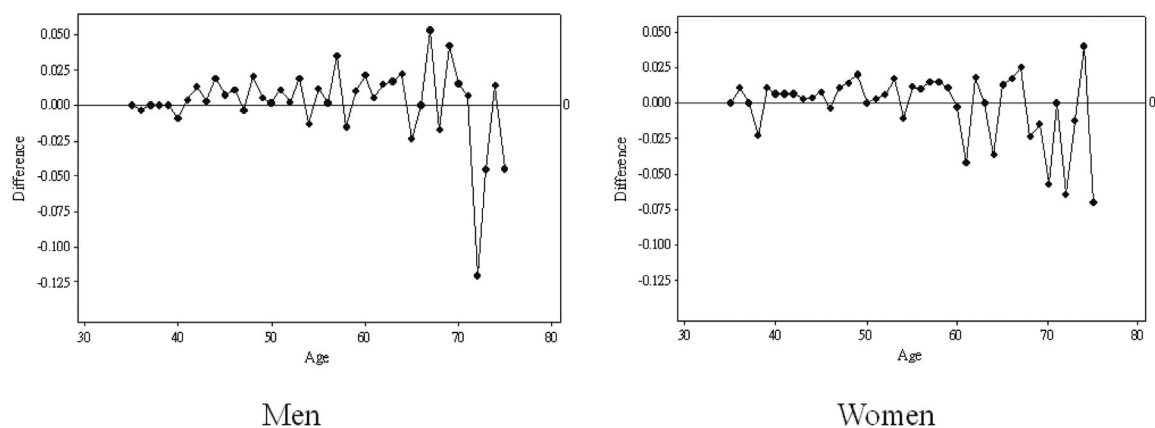


Figure 1. Differences of CIMT vs. Age in Men and Women

cal data with excellent power of explanation from 85.8 % to 91.0 % are shown with the scatter plot of CIMT vs. age of each group shows excellent linear correlation of all (see Figure 2).

Further analysis of CIMT by accumulating of age as groups of 35-40、41-45、46-50、51-55、56-60、61-64 are shown as mean, SD, and 95% confidence interval (CI) in Table 2 with an increment of mean CIMT from 0.012 to 0.04.

The ratio of Lt and Rt side comparative results of CIMT in men and women are calculated for analysis. The results showed decremental ratio of equal CIMT both in men and women from 81.3% down to 56.3% (67.5% as whole) in men and 84.3% down to 56.4% (73.9% as whole) in women as the age groups increased. As for the ratios of different Lt to Rt CIMT were both

incremental in men and women as the age groups increased. The average ratio of L>R to L<R were 1.4 and 1.6 in men and women, with the highest ratio of 2.1 in 41-45 of men and 46-50 of women. See Table 3 for details of No. and percentage of different age groups in sequences of equal, higher Lt and higher Rt CIMT.

DISCUSSION

We found an excellent linear correlation of CIMT to age from 35 to 64 in men and women of asymptomatic persons of Taiwan. Below 35, both the cases No. and the expectation of atherosclerosis are low, so we didn't include this group to have linear correlation prediction for CIMT vs. age. Above age 65, the differences line of CIMT begins to go up and down and also the case No. of

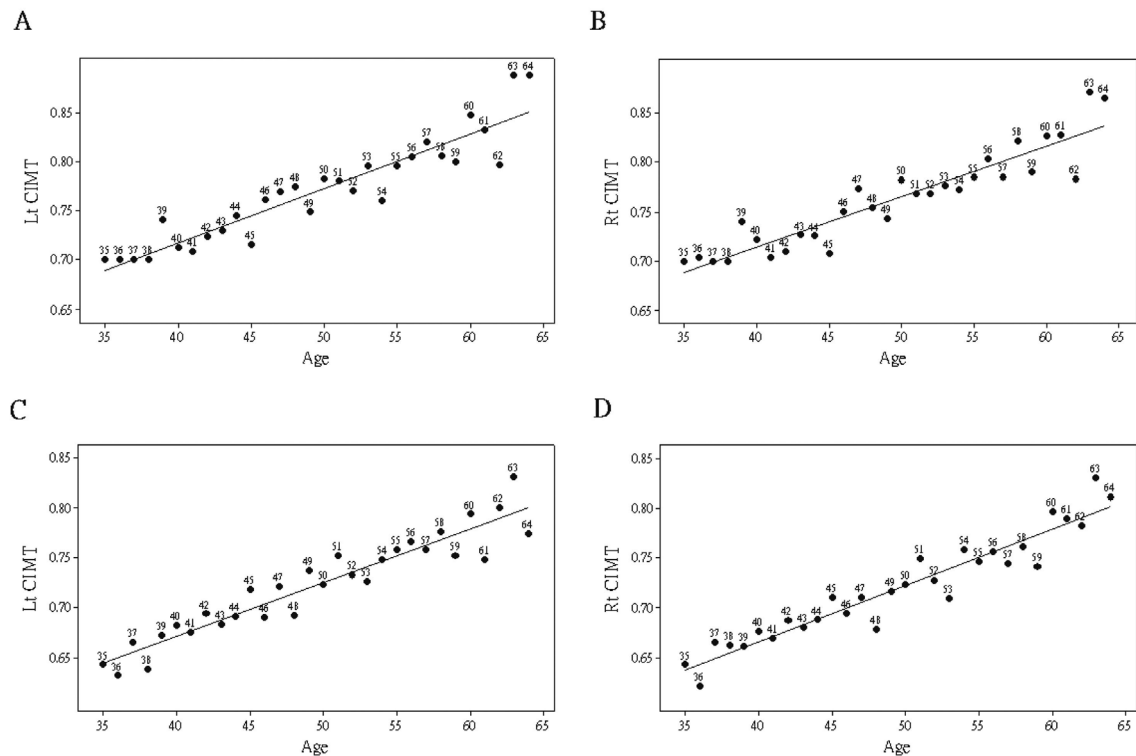


Figure 2. Scatter Plot of CIMT vs. Age in Men's Lt and Rt and Women's Lt and Rt

- A. : Scatter plot of CIMT vs. age in CIMTML; Regression Equation= $0.492 + 0.00561 \text{ age}$; $S=0.0194609$; $R=87.0\%$
- B. : Scatter plot of CIMT vs. age in CIMTMR; Regression Equation= $0.510 + 0.00511 \text{ age}$; $S=0.0185717$; $R=85.8\%$
- C. : Scatter plot of CIMT vs. age in CIMTWL; Regression Equation= $0.456 + 0.00538 \text{ age}$; $S=0.0166136$; $R=89.4\%$
- D. : Scatter plot of CIMT vs. age in CIMTWR; Regression Equation= $0.440 + 0.00565 \text{ age}$; $S=0.0159347$; $R=91.0\%$

each year is relative low. The excellent linear correlation of CIMT vs. age lies from age 35 to 64 in all four groups in our study. For those above 65, whether linear correlation does exist or not remains to be proved by further study. Some studies had reported an age-dependent decline in the correlation of vascular risk factors to carotid atherosclerosis^(7,8), while others found that these factors continue to be associated with carotid atherosclerosis in old age^(9,10). However, The Berlin Ageing Study found that there is significant diminished effect of vascular profile to atherosclerosis above 70⁽¹¹⁾, which was compatible with our observation. Therefore, for age above 65, different consideration of the effect of risk factors to atherosclerosis should be made for CIMT study.

We demonstrated that CIMT is significantly different from men to women as shown by previous studies including those from Taiwan^(5,6,12,13). We also confirmed that the CIMT is different significantly higher in Lt than

Rt as in Taiwan's previous reports⁽⁵⁾. But they did not test according to this difference rather than used averages of Lt and Rt CIMT⁽⁵⁾. Though showing different and higher in Lt CIMT of men and women, statistically, it is not always higher through all cases. In fact most CIMT, about 2/3 for men and 3/4 for women are equal in Lt and Rt. For CIMT that Lt larger than Rt, it is about 1/5.5 for men and 1/6.3 for women. For CIMT that Lt smaller than Rt, it is about 1/7.2 for men and 1/10.0 for women, and the ratio of Lt>Rt / Lt<Rt is 1.3X in men and 1.6X in women. For different age groups, Lt>Rt / Lt<Rt is from 1.1X to 2.1X (mean 1.4X) in men and 1.3X to 2.1X (mean 1.6X) in women with maximum 2.1X in 41-45 age group in men and 46-50 age group in women. There is no explanation of this phenomenon for the time being. Further study to clarify the mechanism of it is mandatory.

Further grouping of data to about 5 years' period

Table 1. The Difference of CIMT Comparing Left vs. Right for Men and Women and Men vs. Women for Left and Right

Sex	No	Left: Mean (SD)	Right: Mean (SD)	P-Value*
Men	1323	0.776 (0.110)	0.768 (0.100)	0.000
Women	1079	0.726 (0.088)	0.721 (0.087)	0.004
P-Value†		0.000	0.000	

* Lt vs. Rt; † Men vs. Women.

Table 2. Mean, SD and 95% CI of CIMT in Lt and Rt of Men and Women for Different Age Groups

Age groups	Men						Women					
	No	Lt CIMT Mean (SD)	95% CI	Rt CIMT Mean (SD)	95% CI	P-Value	No	Lt CIMT Mean/ (SD)	95% CI	Rt CIMT Mean/ (SD)	95% CI	P-Value
35-40	144	0.71241 (0.07254)	(0.70050, 0.72415)	0.71448 (0.07816)	(0.70165, 0.72731)	0.614	115	0.65948 (0.06322)	(0.64786, 0.67111)	0.65603 (0.06762)	(0.64406, 0.66876)	0.373
41-45	174	0.72629 (0.07728)	(0.71476, 0.73782)	0.71600 (0.05849)	(0.70727, 0.72473)	0.012	179	0.69153 (0.06294)	(0.68249, 0.70085)	0.68701 (0.05936)	(0.67783, 0.69535)	0.195
46-50	282	0.76619 (0.08760)	(0.75632, 0.77678)	0.75943 (0.08101)	(0.75008, 0.76894)	0.122	276	0.71408 (0.06850)	(0.70598, 0.72218)	0.70542 (0.06708)	(0.69748, 0.71335)	0.006
51-55	329	0.78165 (0.10076)	(0.76993, 0.79138)	0.77370 (0.09191)	(0.76404, 0.78371)	0.049	225	0.74311 (0.09335)	(0.73085, 0.75537)	0.73733 (0.09128)	(0.72534, 0.74933)	0.210
56-60	268	0.81455 (0.13059)	(0.79882, 0.83007)	0.80373 (0.11212)	(0.78958, 0.81633)	0.078	206	0.76748 (0.09031)	(0.75507, 0.77988)	0.75728 (0.0873)	(0.74528, 0.76928)	0.054
61-64	126	0.8433 (0.1313)	(0.82030, 0.86640)	0.8307 (0.1238)	(0.80880, 0.85160)	0.138	78	0.78970 (0.1014)	(0.76690, 0.81260)	0.8051 (0.0992)	(0.78280, 0.82750)	0.096

Table 3. No. and Percentage of Equal, Lt>Rt and Lt<Rt CIMT in Different Age Groups of Men and Women

Age groups	Men				Women			
	No	Lt CIMT = Rt CIMT (%)	Lt CIMT > Rt CIMT (%)	Lt CIMT < Rt CIMT (%)	No	Lt CIMT = Rt CIMT (%)	Lt CIMT > Rt CIMT (%)	Lt CIMT < Rt CIMT (%)
35-40	144	117 (81.3)	14 (9.7)	13 (9.0)	115	97 (84.3)	10 (8.7)	8 (7.0)
41-45	174	140 (80.5)	23 (13.2)	11 (6.3)	179	142 (79.3)	22 (12.3)	15 (8.4)
46-50	282	180 (63.8)	55 (19.5)	47 (16.7)	276	221 (80.1)	37 (13.4)	18 (6.5)
51-55	329	222 (67.5)	63 (19.1)	44 (13.4)	225	161 (71.6)	38 (16.9)	26 (11.6)
56-60	268	163 (60.8)	59 (22.0)	46 (17.2)	206	132 (64.1)	46 (22.3)	28 (13.6)
61-64	126	71 (56.3)	30 (23.8)	25 (19.8)	78	44 (56.4)	22 (28.2)	12 (15.4)
Total	1323	893 (67.5)	244 (18.4)	186 (14.1)	1079	780 (73.9)	183 (16.2)	116 (9.9)

showed more clearly stepwise increase of CIMT in all four groups (see Table 2). The gaining of CIMT each year though significantly increasing, it is actually quite little, hence, rational to grouping it to 5 years' period.

The regression equations of age in four groups as shown in the legends of Figure 2 lead to the conclusion that for men's Lt CIMT it is about 0.49 at 35 and gaining of 0.00561 every year; men's Rt CIMT is about 0.51 to start at 35 and gaining of 0.00511 every year; women's Lt about 0.46 at first and gaining of 0.00538 every year; women's Rt about 0.44 at first and gaining of 0.00565 every year. Comparing to data from Taiwan⁽⁵⁾ at 0.005, Japan⁽¹⁴⁾ at 0.009, and others at 0.06⁽¹⁵⁾, 0.01⁽¹⁶⁾ and 0.02⁽¹⁷⁾ mm/year, our data show range from 0.0051 to 0.0057 mm increasing of CIMT per year, which is quite consistent to previous data from Taiwan⁽⁵⁾. However, the previous results were not in separation of men and women, Lt and Rt and our results showed more detail for these four groups.

We confirmed significant differences of sexuality and Lt-Rt sides and analysis in separation of groups accordingly. Due to these difference, we recommend that further study concerning CIMT should be grouping according to different sex and side as well, rather than most previous studies^(12,15,18).

We have demonstrated an excellent linear correlation of CIMT vs. age of 35-64 in separation of four groups: Lt and Rt of men and women. Further accumulation of age to about 5- year period showed increment of mean CIMT from 0.012 to 0.04 of each period.

The ratio of different Lt and Rt CIMT showed lower at low age group and increased with aging in men and women. Thus, in youth age most people have same Lt and Rt CIMT. The ratio of Lt>Rt to Lt<Rt of CIMT showed maximum of 2.1X at age 41-45 in men and 46-50 in women.

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